CARPENTRY AND JOINERY

Technical Publication No. 19

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COMMONWEALTH OF AUSTRALIA
DEPARTMENT OF LABOUR AND NATIONAL SERVICE
INDUSTRIAL TRAINING DIVISION

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PREFACE

1. While this manual was originally prepared for the use of trainees in Carpentry and Joinery under the Commonwealth Reconstruction Training Scheme, there has been a considerable demand for copies for use in State Technical Institutions, and by Industry, for the training of apprentices and students in Carpentry and Joinery, and it is now being reprinted for these purposes. It is not intended to be a complete text-book on Carpentry and Joinery, but if used intelligently, it should shorten the period of training.

2. The purpose of this manual is -

(a) For use in class for individual study, for assigned work, and for reference purposes.

(b) To reduce to a minimum, note taking by the trainee.

(c) For revision and study in the evening.

(d) For retention as a permanent record for reference after completion of the course.

3. Acknowledgment is made of the assistance given by the Division of Forest Products of the Council for Scientific and Industrial Research by preparing the sections on the following topics:- The Structure of Wood, Seasoning of Timber, Grading of Timber, Mechanical Properties of Timber and Factors Affecting Them, Decay of Timber, Borers, Termites, and Glues and Gluing.

4. In this manual the sections dealing with carpentry practice have been related to the building of simple structures, such as a garage and an outhouse. In each building different types of doors, windows, and roofs have been introduced so that the trainee may become familiar with as many varieties of design as possible. The principles learned in the construction of these small buildings can be adapted to the construction of dwellings and larger buildings.

5. The whole aim of theory is to enable the trainee to under - stand better what he is doing and why he is doing it, thus making him a more efficient tradesman. The theory learned should be related to the practical work in the shop and on the job.

6. Today "near enough" is not good enough. The standard of work done by a tradesman must always be of the highest quality. Efficiency can only be achieved by careful study and constant practice, and by insistence on the highest standard of work at all times

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THE QUALIFICATIONS OF A CRAFTSMAN.

Craftsmanship is the skill employed in doing a job properly, and a good craftsman is the one who has complete mastery over tools and material, and who uses them with skill and honesty. The efficiency of the modern building still depends upon the sincerity of its building. A good craftsman does not do a job in a haphazard way. Practical experience of trial and error and perseverance and thought, extending over many centuries, have taught him the best way to do it. The accumulated results of such experience have been handed down from craftsman to apprentice from generation to generation.

Carpentry and Joinery is a highly skilled craft, with a long and proud tradition, and one to which a man can be proud to belong. It calls for initiative and constructive ability and demands great care and precision, as the jobs to be done must be worked to fine limits to ensure accuracy of fit in all joints.

Craftsmanship implies a great deal more than technical knowledge, though technique is naturally an important element in it. A craftsman must be prepared to give of his very best at all times, to strive for perfection and to cherish an ideal, however difficult it may seem at the time. His work is judged solely by his efforts, by the tangible things he does.

PRESENT DAY INFLUENCES.

The evolution of woodworking to its present highly efficient state is characterised by the increasing practice of craftsmen to specialise in particular sections. Specialisation makes for economic production and this factor alone is responsible for the segregation of sections of the building industry.

Some of the chief influences which affect present day craftsmanship in wood are due to -

(a) Progress in Social and Economic Life. The gradual levelling up of the standards of living has led to a demand for better building.

(b) Introduction of other Structural Materials. The use of steel and concrete as constructional materials has caused very great changes in carpentry work. Steel work has limited the use of timber as a structural material, while concrete has created additional work for the carpenter in the preparation of moulds in which to cast the concrete.

(c) Scientific Research on Materials and Methods of Construction. This not only implies a further knowledge of the properties of traditional materials, but includes the introduction of new materials. Improvements in cementing materials have resulted in a more extensive use of plywood and laminated boards. The technique in the use of these materials is totally different from that of using solid timber. Boards composed of many plys have eliminated the evil tendency of wood to split, warp and twist. Modern ply-boards can be used for almost any purpose for which solid wood is used, externally as well as internally.

(d) Development of Woodworking Machinery. This has brought into being the skilled machinist, and the specialist firms of joinery manufacturers. Precision and accuracy hitherto unattainable are now possible.

(e) Mass Production, the Standardisation of Stock Joinery, and Prefabrication. These have been made possible by the use of the machine which encourages repetition work and standard sizes. Prefabrication is the logical extension of the principle of mass production, and consists of preparing completely finished articles in the factory, ready for installation on the building site. The joinery is produced as a planned unit and is merely assembled on the job. Timber houses, prepared in standard sections, and floor sections and roofs, may be constructed in this manner, while doors, completed in the factory with all fittings and hung to their frames or linings, are examples of organised production created by standardisation.

DEFINITIONS OF CARPENTRY AND JOINERY.

Carpentry may be defined as the structural work on a building. It is almost exclusively employed for the support of weight or pressure: thus strength, durability and rigidity are the chief considerations. The work may be a permanent feature of the building, or it may be only of a temporary nature. In carpentry, wood is invariably referred to as "timber".

Joinery may be defined as the woodwork fittings to a building. As a pleasing appearance is important, end grain, joints, and fixings should be concealed wherever possible, and the finish of the work should receive special consideration. In joinery, wood is referred to as "stuff".

The chief features of good joinery are -

(a) Clean, flat surfaces.
(b) Straight, sharp arrisses.
(c) Close-fitting joints.
(d) Accurate dimensions.
(e) Proper selection and use of material.

Joinery may develop faults by -

(a) Excessive shrinkage, causing warping, checking, and the exposure of joints.
(b) Insufficient care during transit to the site and storage on the building site.
(c) Decay of the material.
(d) Improper fixing.

To avoid defects occurring in joinery, the material should be selected from well-seasoned stock, and wherever possible, should be dried to the required moisture content of the building, and maintained in that condition throughout.

Joinery work is divided into two distinct classes -

(a) Preparation and assembling of the joinery in the workshop.
(b) Fitting and fixing of the joinery on the building site.

Shopwork is divided into further sections, according to the type and methods employed in preparing the joinery :-

(i) The manufacture, or mass production of standardised units of joinery. In this case, all processes are executed on the machine, including the marking out with the aid of jigs and patterns. The assembling of the parts is the only operation done by hand, and this is regarded as a necessary evil to be tolerated only until the machine can replace it.

(ii) Individual work to a special requirement. It is sometimes more economical to do some of the work by hand methods, as the expense involved in preparing cutters and setting up the machine is too costly.

(iii) Good class joinery. This invariably means individual work. The greatest difference between high class joinery and domestic joinery is that more attention must be given to the larger pieces of wood in order to persuade them to remain stable in the positions in which they are fixed.

Fixing joinery on the building site is also divided into two general classes :-

(i) First fixing, which includes the installation of all fixings not completed by the carpenter in carcassing; and

(ii) Second fixing, which includes the final completion of the joinery and the fitting and fixing of all metal fittings.

PRINCIPLES OF CRAFTSMANSHIP.

There are certain fundamental principles of craftsmanship which are vital to all good work -

(a) An understanding of the material used.
(b) A complete mastery of tools.
(c) A knowledge of construction.
(d) Appreciation of good design.

A craftsman must know his material, and have an almost instinctive "feel" of it, and sense of what can be made with it, and a recognition of its limitation and shortcomings. This is imperative because the entire work of the carpenter and joiner is controlled by the nature of the material. Timber is a natural material, each piece of wood being different from every other, and in addition to the execution of the work, the success of the finished work is dependent upon the selection of the right piece of timber for the job in hand. In spite of competition from other materials, timber will still play a large part in the erection and construction of modern buildings.

Wood is limited to certain dimensions dictated by custom and the sizes of trees. An important feature of wood is that it will swell and shrink according to the changes of humidity in the surrounding atmosphere, and this tendency of wood must be taken into consideration.

Craftsmanship is not associated exclusively with handwork. The fact that we live on machine production must be acknowledged. A machine is only a tool, and it needs the hand and brain of a craftsman for guidance, control and maintenance. It does not matter if the craftsman uses a chisel or a spindle moulder, it is the quality of the work that counts. Good work is still good work, whether made by hand or machinery, whether made a thousand years ago or yesterday.

GROWTH OF THE TREE.

To understand properly the methods of sawing, seasoning, identification, preservation, and the properties of timber, it is necessary to know how wood is formed and the general details of its construction.

The tree, like all forms of life, has a cell structure, and begins life as a small seedling with special cells at the tip, which are responsible for height growth. Just below this growing tip there is formed beneath the bark, a cell layer which is continuous around the outside of the tree from tip to root. This layer is called the cambium, and can usually be detected as a sticky layer when the bark is stripped from the tree.

The cambium consists of cells which divide and produce new cells in a horizontal direction, and so is responsible for all the diameter growth of the tree. The cambium produces new bark on the inside of the bark and new wood on the outside of the woody trunk of the tree.

Growth in height occurs only at the growing tip of the trunk, so that wood or bark produced at any particular level in the tree always remains at that height. There is also a growing tip responsible for the extension of each branch of the tree.

The tree is fed by means of sap flow, which starts as water with some dissolved minerals taken in by the roots, carried up the tree in the outer layers of the wood just inside the cambium, to the leaves. Here it is enriched with food manufactured in the leaves with the help of sunlight and it moves down the inner layers of the bark to feed the cambium and so permit growth of the tree.

GROWTH RINGS.

The growth of a tree is affected by climatic conditions, almost ceasing during the winter in cold climates. When the tree is growing rapidly, it produces cells of a different appearance than when it is growing slowly.

This variation is responsible for the growth rings on the cross section of a tree, as shown in Fig. 1.

In cold climates, these growth rings indicate growth year by year and hence are called annual rings. In tropical areas, more than one ring per year is sometimes laid down.

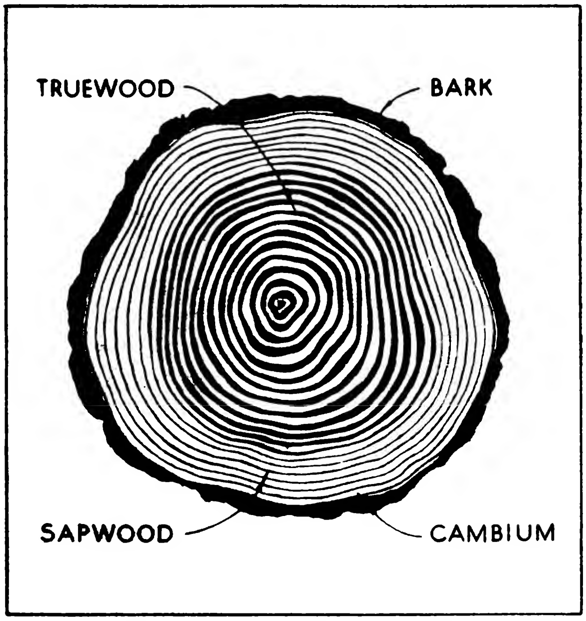


Fig.1 Cross Section of a Tree.

SAPWOOD AND TRUEWOOD.

The cross section of a tree shows certain important zones. At the outside is a zone of light coloured wood, known as sapwood. This contains living cells, and is used as a store for food material, such as starch. Inside the sapwood, is a zone usually darker in colour. This is known overseas as heartwood, but in Australia as truewood, so as not to be confused with the brittle centre present in some trees, and known as heart (brittle heart). The truewood cells are dead cells but the wood often contains substances which greatly increase its durability compared with sapwood. In the centre of the tree is the pith, although this has sometimes disappeared in a log with a pipe or hollow. The pith is sometimes surrounded by an area of rotten wood and brittle heart, particularly in very old trees.

TYPES OF CELLS.

Different types of cells are laid down by the cambium. These include fibres, rays, and pores or vessels. The fibres are the most important from the strength standpoint. They vary from about 1/25th to 1/5th of an inch in length, and are more or less vertical in the standing tree.

The rays are horizontal in the tree, running radially from the cambium towards the pith. They vary enormously in size, being indistinct in many timbers, such as hoop pine and mountain ash, but very prominent in the silky oaks and the sheoaks.

In one main class of timbers there are large open cells, called vessels or pores. These cells are very distinct and, therefore, this class of wood, which is illustrated in Fig.2, has been referred to as the "pored" woods, as distinct from the other main class in which such pores do not occur. This second class of timber, illustrated in Fig.3, is therefore, referred to as the "non-pored" woods. Timbers, such as the eucalypts, oak, maple, hickory, ash, walnut, blackwood, myrtle, mahogany, etc., have the typical vessels of the "pored" woods, and therefore fall into the "pored" wood class. They form a distinct group.

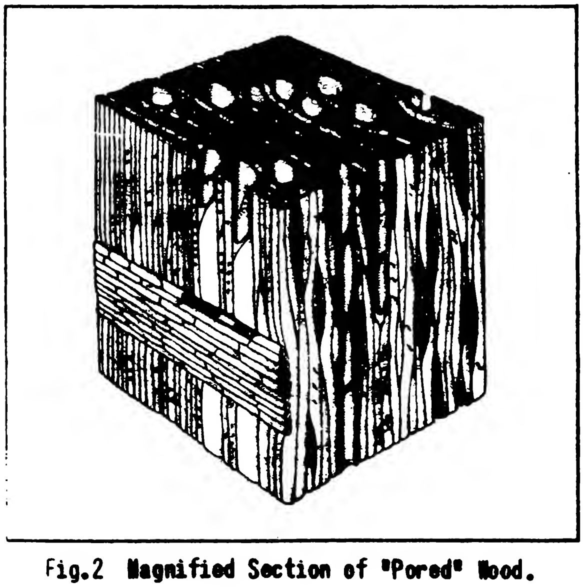


Fig.2 Magnified Section of "Pored" Wood.

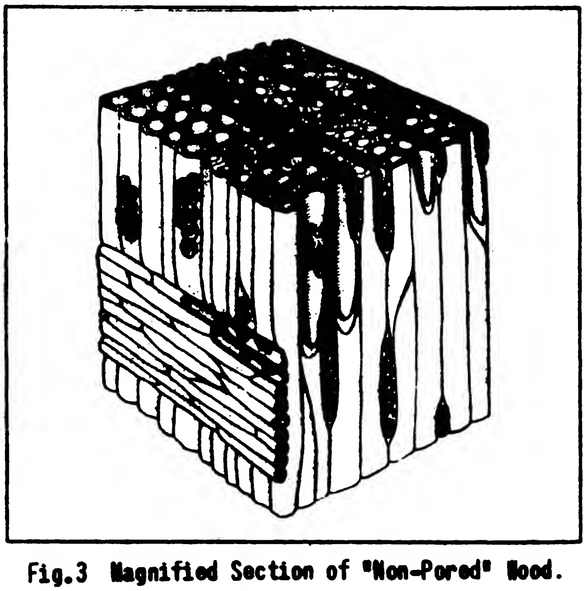


Fig.3 Magnified Section of "Non-Pored" Wood.

The "non-pored" woods, into which class fall the pines, firs, hemlock, Douglas fir, kauri, Cypress pine, spruces, King William pines, etc., also form a definite group. The "non-pored" woods are sometimes referred to as softwoods, and the "pored" woods as hardwoods. These terms, softwood and hardwood, are misleading if used to denote these two classes of woods. A timber such as balsa is a "pored" wood, and therefore would be referred to as a hardwood. Such is manifestly ridiculous to anyone who knows how light and soft balsa is, especially if it is compared with Cypress pine, for instance, which technically, is a softwood timber, but is often hard to cut.

WOOD IDENTIFICATION.

Certain features, such as colour, weight and hardness, are useful in timber identification. The structure of wood can also assist greatly because of variations in size and arrangement of the various types of cells. Examination of an end surface cleanly cut with a very sharp knife, often reveals the identity of a timber, particularly if a hand lens is used to magnify the structure. Some timbers are very difficult to identify and here the microscope in the hands of an expert is necessary.

BACK AND QUARTER SAWING.

The way in which a board is cut from a log has a considerable influence on its properties and appearance. This is illustrated in Fig.4, which shows a backsawn board, or one in which the growth rings tend to run across the width of the board, and a quarter sawn board with the rings running through the thickness.

It will be realised that practical considerations prevent all the timber from a log being wholly back or quarter cut.

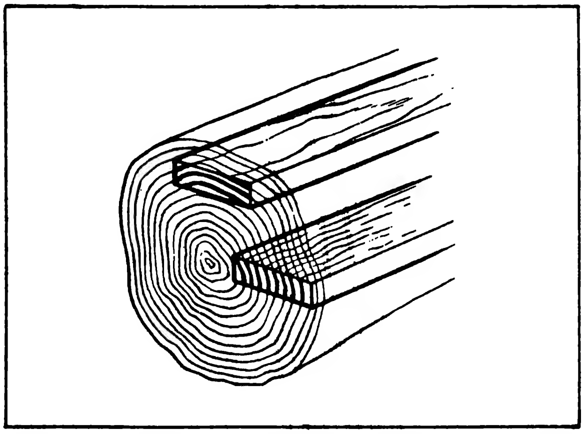


Fig.4 Two Methods of Sawing a Board from a Log.

FIGURE.

In addition to the figure produced by back or quarter sawing, other pleasing effects can be produced by features such as grain irregularities, knots, etc. When logs with wavy grain are sawn, especially quarter sawn, a very beautiful figure (fiddle back) is produced. Figure in timber may also be caused by the presence of knots, either large or small, and the best effects are produced by back sawn faces. So called "bird's eye" figure comes under this type. Figure may also be due to such natural features in particular trees as buttresses, crotches, and burls, and the most beautiful matched effects can be produced with appropriate sawing, slicing, or veneering of the piece.

Several of our timbers show a pleasing figure due to colour variation in the wood, for example, Queensland walnut. Others show a stripy figure when quarter cut, for example, Queensland maple. This is due to the presence of interlocked grain, the effect being due to the varying inclination of the elements in successive layers. Figure may also be due to the texture of the timber.

SECTION 3. SEASONING OF TIMBER

THE MEANING OF SEASONING.

The term "seasoning" means removal of moisture from wood. In green timber the amount of moisture to be removed may be very great; in some cases the weight of the moisture present in the timber may be well over 30 lbs. per cubic foot.

In practice, the process of seasoning is not simple, as timber can be completely spoiled by wrong methods. The problem is to remove a suitable amount of moisture without causing undue degrade in the form of splits or distortion.

THE REASONS FOR SEASONING.

The amount of moisture in wood affects its properties very considerably. As a result, the moisture content of the wood largely determines its suitability for various purposes. The following are some of the properties affected by moisture content :-

(a) Shrinkage. If insufficiently dried timber is used for joinery or cabinet work, shrinking, and possibly splitting, will occur. On the other hand, over dried timber will give rise to swelling and other troubles.

(b) Painting and Finishing. If timber is not dry when paints or other finishes are applied to the surface, the timber will shrink and the finish will crinkle badly. Oil paints will not penetrate moist wood satisfactorily.

(c) Gluing. Wood, high in moisture content, will not glue properly. Wood should be dried to a suitable moisture content to avoid shrinkage which will tend to open up joints or split the timber.

(d) Weight. Green wood is much heavier than dry wood.

(e) Strength. Green wood is weaker than dry wood.

(f) Durability. Moist or wet wood (unless continually under water) may decay or discolour. Furthermore, pressure preservative treatments which depend on the entry of liquids into the wood,are much more easily carried out if the wood is seasoned to a suitable moisture content.

EQUILIBRIUM MOISTURE CONTENT.

Even seasoned wood that has been in use for many years in the form of joinery, house framing, etc., contains some moisture, the actual amount depending upon climatic conditions, e.g., wood used in very dry areas (such as Central Australia) will contain less moisture than wood used in moist areas (such as North Queensland). In the same way the moisture content of wood is generally higher in the rainy season than in the dry season. This seasonal change will continue indefinitely. In other words, the moisture content of seasoned wood at any time depends almost entirely on the temperature and humidity of the surrounding air. The actual moisture content reached by wood when in equilibrium (or balance) with the moisture in the surrounding air is termed the Equilibrium Moisture Content.

The higher the temperature and the drier the air the lower will be the equilibrium content. The time taken for a piece of wood to reach equilibrium moisture content depends upon its size, density (heaviness), and whether it is freely exposed or protected by finishes or other preparations.

This variation in the moisture content tends to cause shrinkage or swelling, the dimension becoming slightly greater when the moisture content increases and slightly less when the moisture content is reduced - an explanation of the alternating jamming and rattling of window frames.

The fact that wood shrinks on drying and swells with moisture increase is well known. These changes in size mainly affect the width and thickness; the length along the grain of the piece being practically unaffected.

EFFECT OF GRAIN DIRECTION ON SHRINKAGE OF TIMBER.

If a moisture content change occurs in a piece of timber, so that normal shrinkage or swelling results, the proportional movement in a backsawn direction will be about twice as much as that in a quartersawn direction. This means that if, for any reason, it is important that minimum changes occur in the width of a piece of wood, it should be quartersawn, whereas if it is important that little change in thickness occurs, the wood should be backsawn.

Since the shrinkages in these two directions are not equal, it follows that wood till tend to change its shape with a change in moisture content. This will be marked during the drying of stock of high moisture content.

For example, a square of wood when high in moisture content with the growth rings parallel to one side, will become rectangular when dry; a similar piece, cut so that the growth rings run diagonally, will tend to become diamond shaped. Wood which is circular in cross section when moist, such as a dowel, will become oval as it dries.

Fig. 1 shows the distortions due to difference between quartersawn and backsawn shrinkage. The difference in A and C is accentuated by collapse. Green sections, of original size and shape, are shown as a background.

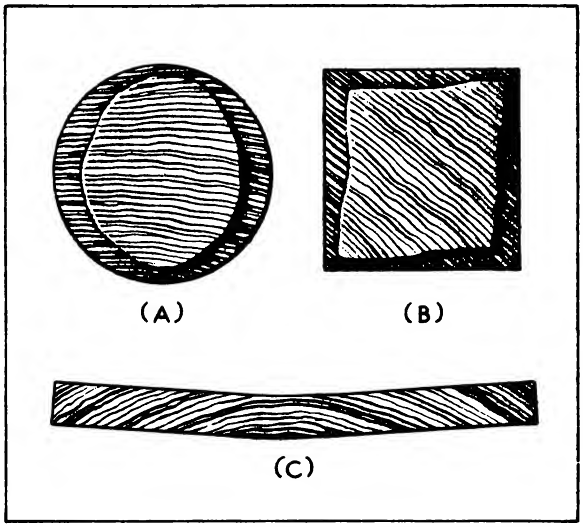


Fig.1 How Grain Direction Affects Shrinkage.

Fig. 1A shows an oval section obtained by drying a round section turned while green.

Fig. 1B shows a diamond shaped section obtained by drying a section cut square when green, with growth rings running diagonally across the section.

Fig. 1C shows a "cupped" backsawn board, showing "cupping" away from the heart.

THE RELATION OF EQUILIBRIUM MOISTURE CONTENT AND SHRINKAGE.

To reduce these changes in size and shape the timber used should be as near as possible to the equilibrium moisture content for the conditions of use. The cramping of floors illustrates the need for an understanding of the equilibrium moisture content. If the moisture content of the wood is a little too high, the floor can be cramped tightly and with subsequent drying out, cracks will not be quite so obvious as they would otherwise be. Flooring boards much too high in moisture content should be avoided. No matter how tightly they are cramped, a poor floor with very open joints will result. However, if the wood is too dry, say 5% below equilibrium moisture content, or when the floor is being laid over a poorly drained, poorly ventilated, or damp, site, the floor should be loosely cramped, otherwise lifting of the boards or badly ridged floor joints will occur.

The following table will prove a useful guide to the moisture content suitable under various conditions of use :-

APPROXIMATE MOISTURE CONTENT RANGE ATTAINED BY WOODEN ARTICLES OR FITTINGS IN SERVICE.

Article	Moisture Content Range (Percentage of Oven Dry Weight)
Agricultural implements	10 - 20%
Boxes and Crates	10 - 17%
Cooperage	12 - 15%
Flooring	8 - 16%
Framing (House)	8 - 20%
Furniture	8 - 16%
Gates and Fencing	8 - 20%
Motor Body Stock	8 - 17%
Patterns	8 - 14%
Ship Construction:	
Cabin furniture	10 - 14%
Decking	12 - 16%
Above water planking	15 - 18%
Diagonal "	18 - 20% *
Under water "	20 - 25% *
Sporting goods	10 - 16%
Stock for Bending	15 - 25%

* These values are practically independent of climatic changes and represent suitable conditions for use.

The moisture content of timber for dry areas should lie towards the bottom of the range shown for that particular case, whereas material for moist areas should lie towards the top of the range. For most of the capital cities of Australia a suitable moisture content for any particular article lies at about the mid-point of the range.

VARIATIONS BETWEEN SPECIES OF TIMBER.

The variation of shrinkage or swelling between different timbers is in some cases even greater than that between different grain directions. Where a small shrinkage is desirable a suitable timber should be chosen.

COLLAPSE.

"Collapse" is a peculiar form of shrinkage. It is distinguished from ordinary shrinkage in that the latter occurs in all woods, whereas collapse occurs to an appreciable extent in only a few timbers and can generally be removed.

Collapse in timber usually appears as irregular shrinkage, ridging across the surface or cupping of the faces, as illustrated in Fig. 2. It occurs, for example, in mountain ash, red cedar, brush box, Sydney blue gum and silky oak.

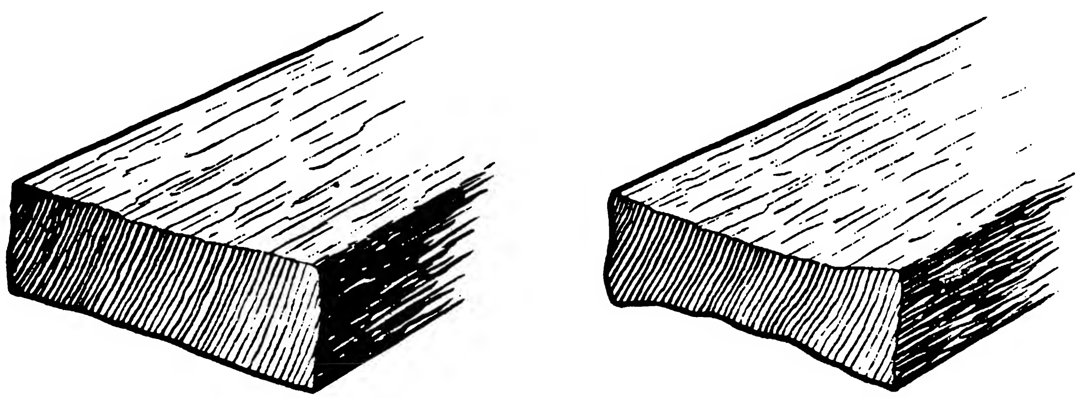


Fig.2 Example of "Collapse" of Timber.

Collapse occurs much earlier in drying than does ordinary shrinkage. The former may develop almost from the time the timber is sawn in the mill, whereas appreciable ordinary shrinkage does not commence until the moisture content has reached about 30%.

Collapse can generally be removed by a "reconditioning" treatment given towards the end of seasoning. To recondition timber containing collapse, it is placed in a closed chamber to which steam is admitted. Several hours are usually sufficient to cause the collapsed timber to recover its shape, after which it is re-dried.

MAIN CAUSES OF DISTORTION.

Seasoned timber may change shape after machining, due to either of the following causes :-

(i) Uneven moisture distribution in the wood, e.g., the centre may be wetter than the surface so that when the interior of the wood is exposed it dries and shrinks.

(ii) Stresses in the wood. These are forces developed in the wood if the surface layers are dried at a somewhat faster rate than the centre. Until the wood is machined the stresses are balanced and it holds its shape. Machining or re-sawing may unbalance these stresses, causing a change in shape, as shown in Fig.3.

Uneven moisture distribution and the presence of stresses are indications of poor drying. They can be removed by a treatment at a high humidity.

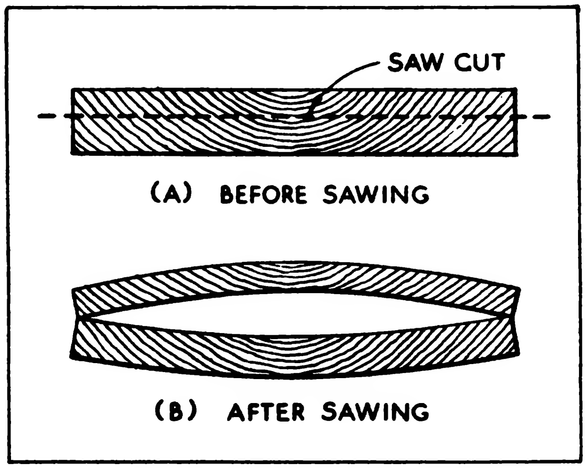


Fig.3 Change of Shape due to Poor Drying.

METHODS OF SEASONING TIMBER.

(i) Air Drying. In air drying, timber is stacked on open supports, so that air can circulate freely under the stack and between the layers. The rate of drying depends upon the speed of air circulation and the temperature and humidity of the air. These factors cannot be controlled, but over a period of time, the timber will dry.

Unless the stacks are covered, unstacking should be undertaken only during dry periods of the year. In some areas the humidity may be too high for the timber to dry to a suitable E.M.V. Nevertheless, much timber is air dried, and is quite suitable for many purposes.

(ii) Kiln Drying. The drying of timber can be hastened by placing it in a kiln in which the rate of circulation and the temperature and humidity are controlled. Usually, the air circulation is provided by fans, the heat by steam heated pipes, and the humidity by steam sprays.

The advantages of kiln seasoning are :-

(a) More rapid drying.
(b) The final moisture content is independent of climatic conditions.
(c) The treatment will kill borers or their eggs (but will not prevent re-infestation).
(d) It is possible to give the timber a corrective treatment for the relief of the stress condition and the removal of moisture gradients in the wood.

For more complete description of air drying, see Trade Circular No.46, issued by Division of Forest Products, Council for Scientific and Industrial Research.

For description of types of timber seasoning kilns, see Trade Circular No.17, issued by Division of Forest Products, Council for Scientific and Industrial Research.

WHY TIMBER IS GRADED.

Timber is subject to defects which may be defined as any irregularity occurring on or in the timber which may lower its strength, durability, or utility value. The individual pieces of timber, obtained when a tree is sawn, vary considerably in quality. Some will be free or practically free from defects, but the majority will contain knots, gum veins, gum pockets, splits and checks, or other defects, some of which are natural to the tree whilst others may have occurred in felling, transport, sawing, or drying. The presence of defects does not necessarily prevent timber from being used satisfactorily for many purposes.

To ensure the best utilization, segregation of timber into grades with a relatively narrow range in quality is necessary. Grading thus permits charging for timber according to quality, and enables a user to buy the lowest grade material which fulfils his requirements.

The grade of a piece of timber is determined by the size, frequency and location of defects. Descriptions of the defects permissible in the various grades are given in grading rules published by the Standards Association of Australia.

FORMATION OF GRADING RULES.

Grading rules are commonly prepared separately for each species of timber, but may cover a group of similar species, used indiscriminately for the same purpose. Consideration is given to the purposes for which the particular timber is suitable, its characteristic defects, and the extent to which these may be present as regards size, number, and position, without affecting the serviceability of a piece for the purpose intended.

There are three major fields of timber usage, namely :-

(a) Building and General Construction.
(b) Manufacturing.
(c) Packing.

BUILDING AND GENERAL CONSTRUCTION.

Building and general construction covers a wide field and consequently there is a considerable variation in quality requirements for these purposes. A high quality is required for mouldings, panelling and linings , which must generally be suitable for natural or light finishes. Timber for polished floors should also be of high quality, but if the floor is to be covered, the chief requirements are that the timber shall be mechanically sound, well seasoned, and accurately machined to the standard profile.

Weatherboard, internal trim, and other timber which will be painted, may contain irregularities which can be filled or hidden by the paint. Appearance is not important for framing timber which is commonly hidden. The main requirements are sound timber, uniformity of size, reasonable straightness, square edges and accurate profiles.

Timber in designed structures (structural timber) is usually highly stressed and must be more carefully graded, the defects permitted being determined by the load.

MANUFACTURING

Since timber in manufactured articles is usually in small sizes, a few quite large defects may be permitted, as these can quite easily be eliminated in ripping and cross cutting. Overseas, special manufacturing grades are used, so that on re-cutting, a specified percentage of small clear pieces of a certain size will be obtained. The price varies with the percentage recovery.

PACKAGING.

Timber for crates, cases and boxes, should normally be inexpensive and light in weight. Adequate strength should be provided to protect the contents in transport and storage. Packaging timber is generally cut from relatively low grade boards, containing knots and other defects.

GRADING PRACTICE IN AUSTRALIA.

Timber grading is in its infancy in Australia compared with some other countries, especially North America, where active timber organisations have set up grading rules to cover the whole range of material produced. In Australia there has been a tendency to specify for all purposes that timber shall be free from all defects and then, according to actual requirements, accept timber of lower quality.

The fullest example of grading rules for any Australian timbers are those for jarrah and karri, first established by the Western Australian Forests Department, and subsequently, issued by the Standards Association of Australia. These rules cover the full range of products from jarrah and karri.

Other Australian Standard Grading Rules are those for milled flooring, lining, weatherboards, plywood and structural timber. These specifications are comprised of three main parts, namely :-

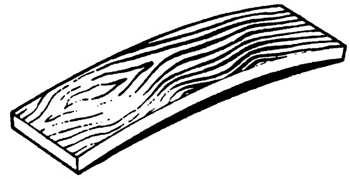
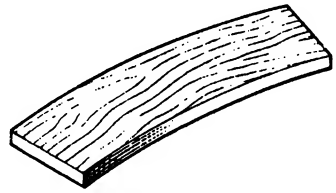
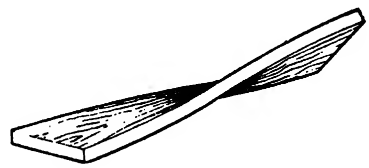
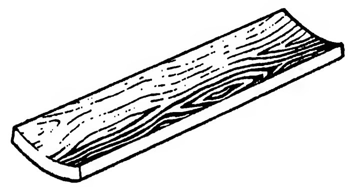
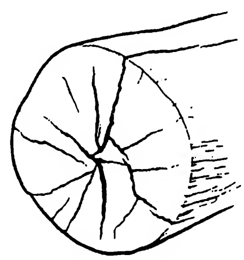
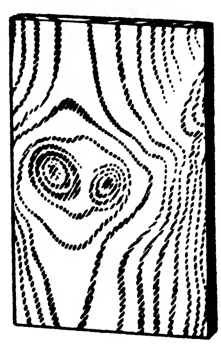
(a) The species permitted.

(b) The general provisions for the use described irrespective of grade. These cover moisture content, density, size, rules for measuring defects, etc.

(c) Grade descriptions. These define the requirements and permissible imperfections in each grade.

DEFINITIONS.

The more common terms used in grading Australian and imported timbers are defined on the following pages. A full list of terms and definitions is available in Australian Standard No.O.1, and the Council for Scientific and Industrial Research (Forests Products Division) Trade Circular No.15, "Terms and Definitions used in Timber Grading Rules".

BOW	A deviation from the flat, the piece becoming arched.	
SPRING	A deviation edgewise, the piece remaining flat.	
TWIST	A spiral distortion along the length of a piece of timber.	
CUP	A curve across the width of a piece.	
SHAKE	A separation between adjoining layers of wood, due initially to causes other than drying.	
KNOT CLUSTER	Two or more knots grouped together as a unit, with the fibres of the wood deflected around the entire unit. (A group of single knots is not a cluster.)	

INTERGROWN KNOT	One in which the growth rings are completely intergrown with those of the surrounding wood.
SOUND KNOT	One which is solid across its face, as hard as the surrounding wood, and free from decay.
TIGHT KNOT	One which is so fixed by growth or position that it will not fall out.
GUM POCKET	A cavity which has contained or contains gum (kino).
PITCH POCKET	A cavity which has contained or contains pitch. (Bark may also be present in the pocket.)
BLEMISH	Anything which mars the appearance of the timber and which is not classed as a defect.
CHECK	A crack running along the grain and formed during drying. (As compared with longitudinal shakes, checks have an order of magnitude of inches only, in length.)
SPLIT	Cracks extending from one surface to another and located at the ends of a piece.
WANE	The absence of wood on the edge or corner of a piece of timber showing the bark or the surface of the sapwood.
WANT	The absence of wood, other than wane, from the face or edge of a piece of timber.
WARP	Any variation from a true or flat surface. (It includes bow, cup, spring, twist, or any combination thereof.)
DECAY	Rot, or partial disintegration of the wood substance, due to the action of wood destroying fungi.
HEART	That portion of the centre of the tree affected by decay, or of no appreciable strength. The term, "brittle heart" is sometimes used to describe this condition.

<u>GRAIN</u>	A term used to indicate the general direction or arrangement of the fibres and other wood elements.
<u>INTERLOCKED GRAIN</u>	The fibres of adjacent layers are spirally inclined in opposite directions.
<u>SLOPING GRAIN</u>	The fibres do not run parallel with the length of the piece of timber.
<u>STRAIGHT GRAIN</u>	An arrangement of the fibres in which they run parallel to the length of the piece when converted.
<u>WAVY GRAIN</u>	A wavy arrangement of the fibres. (This may be known as wavy, curly, or fiddle-back, depending upon the fineness of the wave.)
<u>GROWTH RINGS</u>	Rings on the cross section of a piece of wood, which mark successive stages of growth.
<u>PITH</u>	A small soft core running along the structural centre of the log.
<u>SAPWOOD</u>	Timber from the outer layers of the log, which, in the growing tree, contained living cells. The sapwood is generally lighter in colour than the truewood.
<u>GUM VEIN</u>	A ribbon of gum between growth rings which may be bridged radially at short intervals by wood tissue.
<u>LOOSE GUM VEIN</u>	One in which the wood bridges are widely spaced.
<u>TIGHT GUM VEIN</u>	One in which the wood bridges are closely spaced.
<u>KNOT</u>	A branch or limb embedded in the tree and cut through in the process of manufacture. (Knots are classified according to form, quality, and occurrence.)
<u>ENCASED KNOT</u>	One in which the growth rings are not completely intergrown with the surrounding wood.

MECHANICAL PROPERTIES OF TIMBER.

The mechanical properties of wood are a measure of its ability to resist external forces. They largely determine the suitability of wood for building purposes, vehicles, tool handles, etc. A knowledge of these properties is obtained by experiments in a laboratory using special apparatus, or by service tests under the actual conditions of practice. The following are terms relating to mechanical properties :-

(a) Stress and Strain. If a block having a cross sectional area of 10 square inches supports a load of 1000 lb., the force per unit area of cross section is 100 lb. per square inch and is called the "stress". This stress gives rise to a deformation or change in length. If it is 10" long, and under load reduces to 9.99 inches, the deformation is 0.01". The change in length per unit length is 0.001", and is called the "strain".

(b) Static and Impact Loading. A body supporting a dead load, such as the weight of a wall, is said to be subjected to "static" loading. This term is also used for a gradually and steadily applied load which acts for a short period. On the other hand, if a load is applied suddenly, as by a weight dropped on to a body, a sudden shock results and the body is said to be subjected to "impact" loading.

In bridges and buildings the load is usually a combination of a static load with a certain degree of impact. In a railway bridge, the beams are subjected to a static load due to their own weight and that of the decking, sleepers and rails. When a train comes on to the bridges they experience an additional static load due to its weight, and an impact load due to the inevitable shocks associated with its movement.

(c) Types of Stress. There are three types of stress, namely, tension, compression, and shear.

When a force acts on a body in such a way as to stretch it, it is said to be in tension. The tensile forces may act along the grain of the timber or at right angles to it, giving rise to tensile stress parallel to the grain or perpendicular to the grain. If the grain is sloping, there is a combination of these two stresses.

Fig. 1 illustrates the comparative tensile strength of wood at different angles to the grain. In this case, the timber withstands a force of 1 unit acting perpendicular to the grain, 20 units when acting against a sloping grain, and 45 units when acting parallel to the grain.

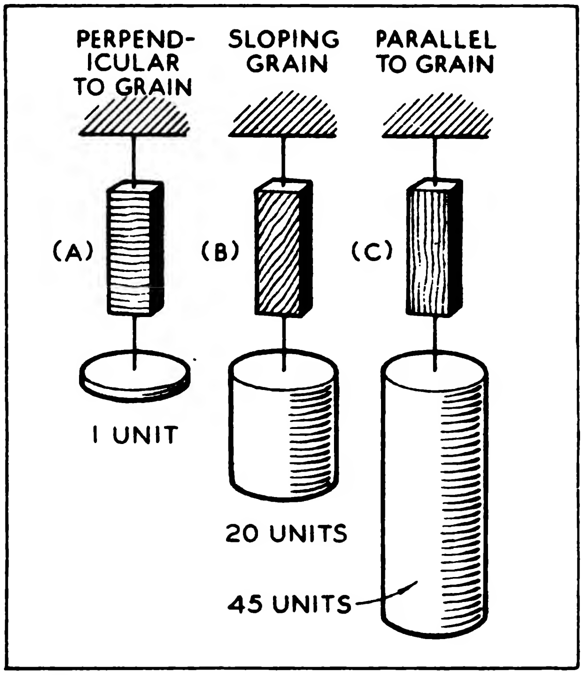


Fig.1 Comparative Tensile Strength of Wood.

When the applied forces tend to decrease the length of a body it is said to be in compression. As with tensile stresses, compressive stresses may be parallel or perpendicular to the grain, e.g., compressive stress parallel to the grain occurs in house stumps and compressive stress perpendicular to the grain in floor bearers where they rest on the stumps.

When the applied forces cause part of the body to slide over an adjacent part, shearing stresses are said to be present. These are unimportant in ordinary building practice.

(d) Stiffness. Stiffness is a measure of the ability of a body to resist change of shape. If a small load is applied to a body and removed, then a somewhat larger load is applied and removed, and so on, at first it regains its shape and is said to be "elastic".

The point is soon reached after which the recovery is incomplete. This point is known as the "elastic limit". Beyond it, the deformation only partly disappears on removal of load due to "plasticity" of the materials. The material is then permanently injured. This takes place considerably below the maximum load the material will carry. A perfectly plastic substance has no elasticity and would be permanently deformed by the smallest load. Wood becomes more plastic when wetted or heated.

The measure of stiffness is called the "modulus of elasticity", the word "modulus" meaning measure. The stiffness generally remains constant until the elastic limit is reached.

BENDING.

(a) Bending of Beams. If a block of rubber, such as is shown in Fig.2A, is marked with a series of parallel lines $\frac{1}{2}$" apart, it will be seen that when the block is bent as shown in Fig.2B, the lines are no longer parallel but are further apart at the lower edge and closer together at the upper. Along the centre line (the neutral plane) the lines are still $\frac{1}{2}$" apart, showing that neither stretching nor compression has taken place.

Thus, the rubber is in tension below the neutral plane and in compression above. As can be seen from the spacing of the lines, the stress increases from the neutral plane outwards.

The same conditions apply to beams made of any material, although with a stiff material, such as wood, the stretching and contraction are not visible to the naked eye.

In addition to the tensile and compressive stresses in a beam, shear stresses are set up parallel to the long axis; they are a maximum at the neutral plane.

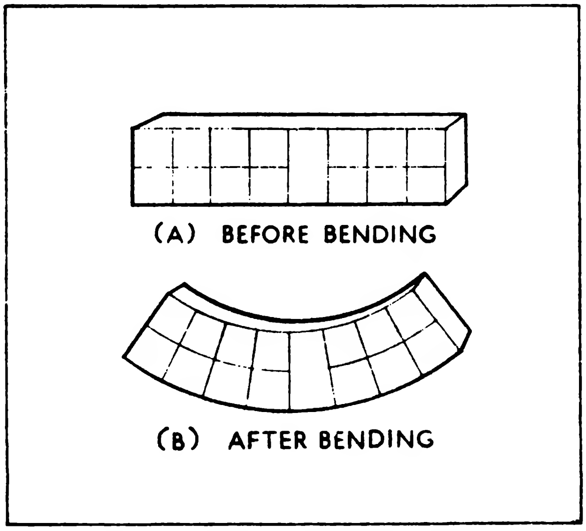


Fig.2 Effect of Bending a Beam.

(b) Modulus of Rupture. As the load on a beam increases, the tensile, compressive, and shearing forces increase also, until a point is reached when the material fails and the beam fractures.

In wooden beams failure usually occurs first on the compression or concave face, as shown in Fig. 3A, followed by failure in tension on the convex face, as shown in Fig. 3B.

The "modulus of rupture" is a measure of the maximum compressive or tensile stress in the fibres at the point of fracture and thus a direct measure of the strength of wood in bending. Thus, a beam having a modulus of rupture of 20,000 lb. per square inch is twice as strong as one having a modulus of 10,000 lb. per square inch.

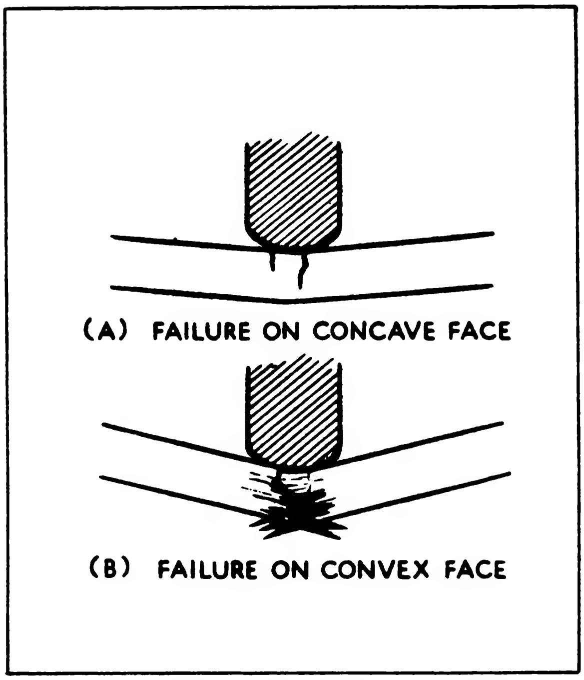


Fig.3 Steps in the Failure of a Beam.

(c) Influence of Dimensions on the Strength and Stiffness of a Rectangular Beam.

(i) Strength. The bending strength of a rectangular beam increases with increase in width of the beam; that is, if the width is doubled so is the strength. It increases as the square of the depth; that is, if the depth is doubled, the strength is multiplied by four. It decreases as the span increases; that is, if the span is doubled, the strength is halved.

(ii) Deflection. The deflection increases as the cube of the span; that is, if the span is doubled, the deflection is multiplied by eight. It also increases as the width decreases; that is, if the width is doubled the deflection is halved. It also decreases as the cube of the depth increases; that is, if the depth is doubled the deflection is divided by eight.

The ratio of depth to width must not be increased too much, or the beam becomes unstable, and is liable to twist under load unless supported for example, by herring boning. This does not apply to hanger beams. where the stress is low because the criterion is stiffness.

(d) Concentrated and Distributed Load. A beam can carry twice as great a load distributed over the whole span (e.g., a brick wall supported on a beam), as one concentrated in the centre (such as a central wheel load).

TOUGHNESS AND BRITTLENESS.

In technical language, toughness is a measure of impact strength, i.e., its ability to resist shocks and blows. A high degree of toughness is necessary for tool handles and sporting goods.

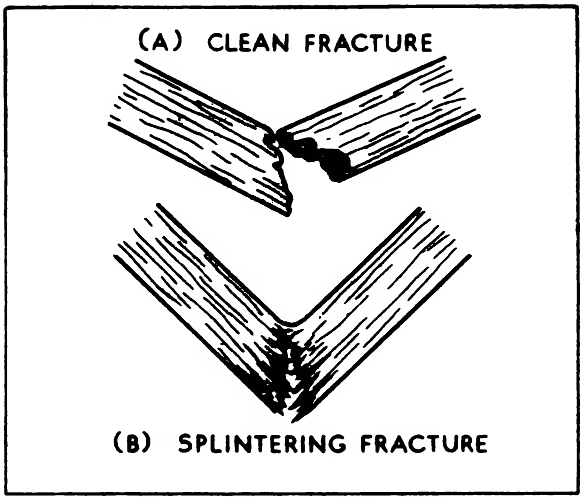


Fig.4 Two Types of Fracture.

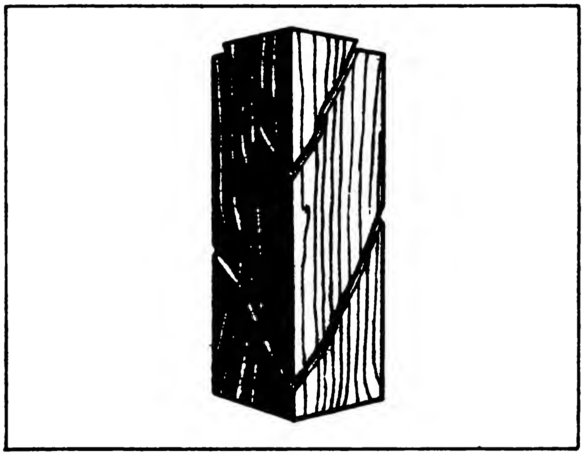


Fig.5 Example of Severe Cross Grain in Timber.

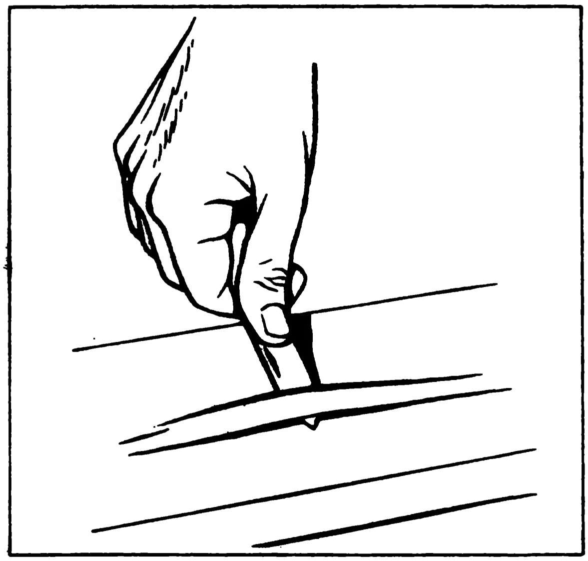


Fig.6 Method of Testing the Slope of the Grain.

A substance which cannot undergo much change of shape without fracture, is said to be "brittle". Brittleness in wood may be due to knots, sloping grain, or other defects, or to brittleness of the wood fibres themselves. Brittle wood breaks suddenly with a clean or carrotty fracture, as shown in Fig.4A, as distinct from a fibrous or splintering fracture of tough wood, as shown in Fig.4B.

MAIN FACTORS AFFECTING THE STRENGTH OF WOOD.

The strength of wood depends on two main factors, namely, natural variations, such as species differences, and the presence of defects. It is important to know the effect of the latter, so that weakening due to them may not be disregarded.

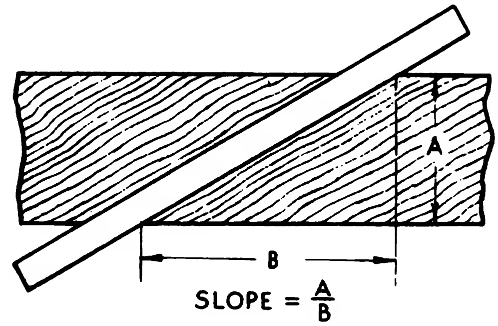
The chief defects affecting the strength of timber are knots, checks, shakes, sloping grain, cross grain, decay, brittle heart, compression wood, borer holes, gum veins, and want.

(a) Sloping Grain. Fig.5 shows a block of wood containing severe cross grain, the growth of rings being parallel to the length but the piece having severe tangential sloping grain as shown by the splits. At first sight, it appears to be perfectly straight grained and the slope of the grain can only be detected by careful examination or by lifting a small piece of the wood with a knife inserted at right angles to the apparent grain direction, as shown in Fig.6.

In hardwoods, the direction of the pores or gum veins usually shows its presence, whilst in softwoods resin ducts of seasoning checks may help. It may also be detected by the plane tearing out chips showing that the grain runs into the piece. Interlocked grain may be indicated by chipping in stripes.

One of the main features of wood is its great difference in strength along and across the grain, e.g., in tensile strength the value along the grain is 25 to 45 times that across the grain. In compression the ratio is 6 to 10 times. Thus, cross grain will greatly reduce the strength of the wood. The method of measuring the slope of grain, and the approximate reduction in strength, is shown in Fig. 7.

The reduction in stiffness is about two-thirds that in strength. It is thus seen that a slope of grain 1 in 15 in beams will only cause 11% reduction in strength. In short columns (ratio of length to least dimension less than 12), the strength is only reduced by 7% for a cross grain of 1 in 5.



SLOPE OF GRAIN	REDUCTION IN STRENGTH
1 in 25	4 per cent.
1 in 20	7 per cent.
1 in 15	10 per cent.
1 in 10	20 per cent.
1 in 5	45 per cent.

Fig.7 How to Measure the Slope of the Grain.

In long columns, where stiffness is the criterion, 1 in 10 will cause about 12% reduction in strength. Where shock resistance is important, not more than 1 in 25 should be permitted. This reduces the strength to 90%. In steam bending, the same limit should be allowed.

(b) Knots. Knots affect ease of working and splitting qualities, and cause warping. Their actual weakening effect is due to local cross grain and checking which may develop around them in drying. An inter-grown knot may be even more weakening in tension than a knot hole of the same size. However, decay is often found around a loose knot, or knot hole, and this may cause the surrounding wood to be considerably weakened.

Knots do not greatly affect the stiffness of wood but may materially reduce the breaking strength of a beam. The effect of knots in beams depends largely on their location. On the convex side of a beam which is in tension, they are far more serious than on the concave side in compression. They have little weakening effect near the centre of a beam where shear is predominant and may even increase the shear strength.

In general, the nearer the knot to the top or bottom of the beam, the more serious it becomes. These facts are of great importance in grading structural timber.

In long columns, where stiffness is important, a knot has little effect, whilst in short columns, reduction in strength is roughly proportional to the size of the knot, the effect being the same as the removal of that portion of material from the cross section. A group of knots within about 6" of each other may be just as serious as if they were one large knot.

(c) Shakes and Checks. Checks and shakes have little effect on the tensile strength parallel to the grain but when tension occurs across the grain, tending to open the checks, their presence may be very serious indeed. In compression they weaken the wood only slightly. In shear, they reduce the shear strength in the same proportion as they reduce the area resisting shear. Thus, in beams they are most serious when running horizontally near the neutral plane. The severity of checks and shakes, other things being equal, depend on the shrinkage, being more severe in timbers with high shrinkage.

(d) Brittle Heart. Brittle heart causes very considerable reduction in the strength of timber, reducing impact strength by as much as 90%. It affects other properties but not to the same extent. Of all the static properties, tensile strength is most affected.

(e) Borer Holes. Pin hole borer flight holes, if not extremely plentiful are not detrimental, but if furniture borers are present it must be remembered that the strength will progressively decrease as time goes on and structural failure will ultimately result. Powder post borer attack is confined to the sapwood which is usually only a small percentage of the total cross section. If the percentage of sapwood is appreciable, the strength of the member should be considered, assuming all the sapwood removed.

(f) Gum Veins. Gum veins are most serious in shear as where they occur they will reduce the shear strength practically to zero. They do not materially affect other properties unless they are extremely prevalent.

(g) Compression Failures. Compression failures are localised wrinkles in the wood, due to compression parallel to the grain beyond the ultimate load. They run approximately at right angles to the grain and generally appear as irregular lines or streaks.

They are due to internal longitudinal stresses set up by growth, abnormal stresses caused by wind, or falling across logs or rocks when felled, or rough handling. They may very seriously impair the strength of wood, especially in impact and tension. In the former case in particular a brittle type of failure results. The bending strength of timber is less affected although they are more serious in this case when on the convex face. They do not appreciably affect the strength in compression. A compression failure is illustrated in Fig.8.

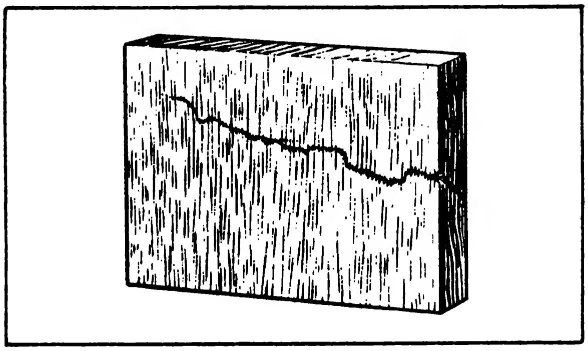


Fig.8 Example of a Compression Failure.

(b) Wane and Want. Wane is the absence of wood on the edge or corner of a piece of timber, showing the Bark or the surface of the sapwood. Want is the absence of wood other than wane, from the corner or edge of a piece. The actual absence of wood will naturally reduce the strength accordingly but the most important feature of wane, especially in small sizes, is the indication they give of sapwood which may be attached by powder post borers.

OTHER FACTORS AFFECTING THE STRENGTH OF WOOD.

The strength of wood is also likely to be affected by its density, moisture content, conditions of growth and temperature.

(a) Density. Density is a guide to strength, provided defects are allowed for. Some properties, such as static bending strength, increase roughly at the same rate as density, whilst others, such as impact bending strength, increase roughly as the square of the density. Nevertheless, the strength of different timbers of the same density may still vary quite considerably. In other words, dense timber is usually stronger.

(b) Conditions of Growth. Wood laid down in the early part of the growing season is generally low in density, while that laid down later in the season is denser and stronger.

(c) Moisture Content. As wood dries it increases in static strength. Some timbers decrease in impact strength, however, as they dry. For example, softwoods, and some hardwoods, decrease whilst other hardwoods increase. Above about 30% moisture content strength does not change, but below this value a change occurs which, for static properties, becomes more rapid as the moisture content falls.

In hot, dry climates, the timber may be at 6% moisture content or less in the summer, whilst in the monsoon areas of northern and eastern Australia it may rise to 18% or more in the rainy season. Thus, the strength of a piece of timber varies with locality and time of year. For instance, in hoop pine this would represent a change in compressive strength parallel to the grain from 9,100 lb. per sq. inch to 5,800 lb. per sq. inch.

Large sized timber dries very slowly , and hardwood bridge stringers may still be green in the centre when the bridge is dismantled, so that for structural timber the strength green is generally used to calculate their strength, as even if they dry, in larger sizes checking will balance the increase in strength due to the fall in moisture content.

The average increase in strength properties of wood per 1% decrease in moisture content in sizes which can be and are dried without checking is as follows :-

Static bending strength	4%
Stiffness	2%
Impact bending strength	0.3%
Compressive strength and shear strength	4%
Tensile strength	1%

(d) Temperature. Temperature has a marked effect on the strength of wood. In general , strength properties and the modulus of elasticity decreases with increase in temperature. Impact strength however, sometimes increases with increase in temperature, this probably being due to an increase in flexibility. As an example of the change which takes place, compressive strength decreases about 12-15% when the temperature rises from 60° to 90° F. In other words, in cold stores etc., ordinary sizes will be quite safe but in warm places, such as malt houses, kilns etc., timber should be oversize.

WORKING STRESSES AND FACTOR OF SAFETY.

It will be appreciated from the foregoing that it is not safe to use the ultimate strength in the design of structures. The stresses used in design "working stresses" are obtained by dividing the ultimate stresses by a factor known as the "factor of safety". Thus, if the average modulus of rupture of a certain species is 10,000 lb. per sq. in. and a factor of safety of 5 is decided upon, the working stress would be 2,000 lb. per sq. inch.

It must not be thought that because a structure has a factor of safety of 5 it is capable of withstanding five times the designed load. Actually, it might carry only one and a half times the designed load for an indefinite period. The factor of safety has to take care of the variability in the strength of clear wood, changes in moisture content and temperature, the influence of defects, the duration of loading, deterioration during the life of the structure and accidental overloading.

STRENGTH GRADING.

Grading rules have been framed by the Standards Association of Australia to provide timber of good strength. There is a "select" grade provided having three-quarters of the strength of clear timber; and a "standard" grade having the strength of three-fifths that of clear timber. If timber is selected according to these rules, working stresses can be determined for each grade and the timber used to the best advantage. The standard grade is recommended for all ordinary construction. The select grade can be used in special structures such as long span timber connector trusses.

DEFINITION OF DECAY.

Decay, often called dry rot or wet rot, is a breakdown of wood caused by simple plants, called fungi.

CONDITIONS FAVOURING DECAY.

Decay fungi thrive in moist wood. Wood which is completely water-logged, or wood which has a moisture content below 20%, will not decay. For this reason, the timber of buildings, and poles, etc., above ground, does not decay, or because of unusual conditions only rarely, whereas timber in contact with moist earth is subject to a very severe decay hazard.

Foundation timbers placed over badly drained soil reach an equilibrium moisture content at which decay will occur, and exposed timber joints, by absorbing water where the timber faces meet, often provide excellent conditions for decay.

PREVENTION OF DECAY.

(a) Damp-Proof Courses and Ventilation. To prevent decay, timber must be kept dry. No timber which is kept dry will decay. In all buildings, therefore, damp-proof courses must be efficient, and there must be adequate ventilation beneath the floors. Lack of ventilation, and the failure to provide suitable damp-proof courses, are the commonest causes of decay in floors, where most decay in building occurs.

For adequate ventilation, allow 1 to 2 square inches of free air space per foot of wall length, and ensure that there is a straight draught from one side of the building to the other. If necessary, internal walls must be pierced at the appropriate points, to permit these straight air movements. Dead air pockets must be avoided, particularly adjacent to chimney and hearth foundations, and filled verandah and porch floors.

The holes in internal walls should be at least 9" x 6" at intervals of at most 6'. In selecting ventilators, remember that it is free air space, not ventilator area, that counts. Some ventilators, particularly terra cotta types, are very ornamental but are provided with such small openings that they are of little use. Good and bad types of ventilators are shown in Fig. 1. Ventilators must not be blocked by rubbish or vegetation.

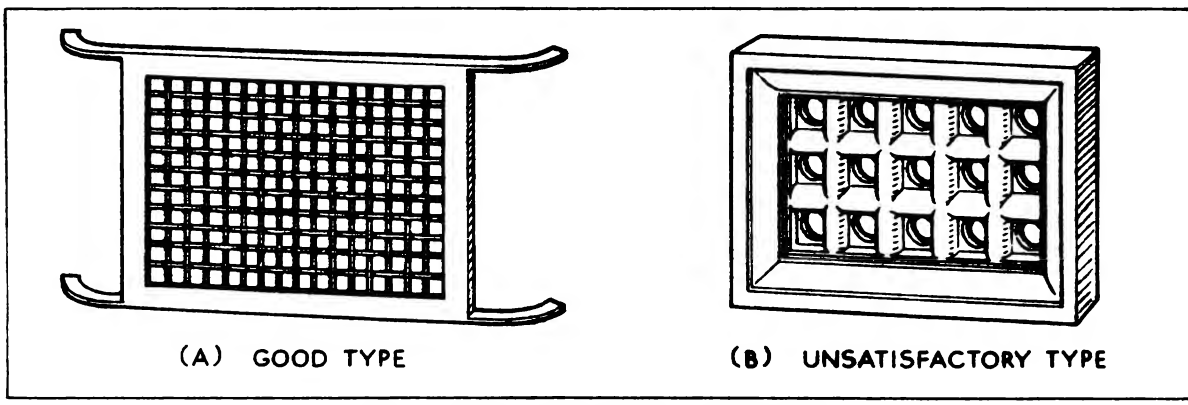


Fig.1 Good and Bad Types of Ventilators.

(b) Use of Resistant Timbers. Where timber cannot be kept dry, e.g., house stumps, garden edgings, etc., durable species, such as red gum, iron bark, bloodwood, or jarrah, must be used.

(c) Use of Paint. Paint serves an important purpose in protecting wood surfaces from the weather. Unprotected wood surfaces absorb rain water rapidly, and swell, then shrink on drying. This alternate wetting and drying of the surface causes checking and distortion. The surface also disintegrates. All these effects can be observed in old unpainted weatherboards or palings.

Paint, however, does not prevent decay. In fact, paint may actually raise the moisture content of the wood by hindering the evaporation of water which has soaked in through cracks in the paint coat, and so favour the development of decay.

(d) Use of Preservative Chemicals. Timber joints which are exposed to the weather can be protected to a certain extent by coating the joint surfaces with creosote oil. If the joint is to be painted over, creosote oil must be replaced by copper naphthenate, or other suitable preservative. The life of building stumps and other timbers exposed under moist conditions, can be increased slightly by the same means.

This gives surface protection only, for a few years at most. Once timber has decayed beneath the layer of preservative, further applications are valueless, unless the decayed wood is completely removed.

It should be borne in mind that the seasoned truewood of Australian hardwoods cannot be penetrated by preservatives by simple methods. No type of preservative which is applied by painting, spraying, or dipping, will penetrate truewood.

ERADICATION OF DECAY.

If decay is found in timbers in contact with the ground these must be replaced with durable timber, or if this is not available, with concrete. If decay is found in timber not in contact with the ground then search should be made for leaks, failures in the damp-proof courses, or blockages in the ventilation system. If leaks are prevented, and the damp-proof courses and ventilation system are in good order, then decay cannot continue to develop. Hence, any decay which may be present after the repair work has been carried out, will simply die out.

DEFINITION OF BORERS.

The term "borers" is usually loosely applied in Australia to those insects which bore holes in green or seasoned timber, but it does not include termites, which are usually called "white ants". Termites live in colonies and excavate large irregular cavities in wood, whereas the insects grouped under the name "borers" work singly, each individual insect making its own separate boring which is usually cylindrical and just big enough to contain the insect.

Wood borers pass through two main stages during their life. The first is the larval stage, the second is the adult stage. All the common wood borers are beetles in the adult stage. The rarer types of wood borers include moths and other insects. With the exception of some of the pinhole borers, all the boring is done by the larvae or grubs.

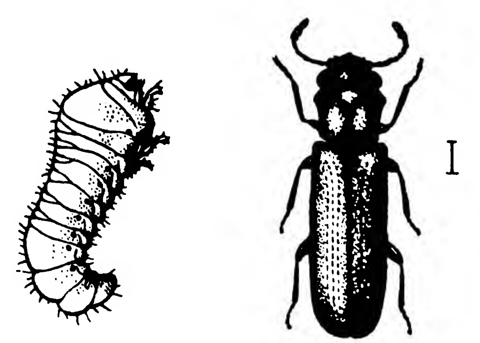
PRINCIPAL AUSTRALIAN WOOD BORERS.

Borers fall into four main divisions in Australia, as follows :-

(i) The Powder Post Borer, or Lyctus. This is the commonest wood borer found in sawn timber in Australia. The larval form, which is responsible for the damage caused, is a tiny curved white grub, and is shown in Fig. 1A.

The adult form, shown in Fig. 1B, is a slender, glossy brown beetle, about $\frac{1}{4}$" in length. Lyctus attacks only the sapwood of hardwoods, both native and imported, which contain sufficient starch to nourish the grub. Two factors limit lyctus attack.

Firstly, the female lays her eggs in the pores of hardwood. A few hardwoods with very small pores, and softwoods such as pine, which have no pores, are therefore not attacked.



(A) LAVAL FORM (B) ADULT FORM

Fig.1 Powder Post Borer, or Lyctus.

Secondly, the eggs are only laid where starch, the food of the larvae, is present. Starch is present in the sapwood, hence this is where the attack takes place. Some species of hardwood rarely, if ever, have sufficient starch for attack, and hence are virtually immune. The hardwoods which are attacked sometimes do not contain sufficient starch, and hence not every piece of sapwood is affected. Truewood is, of course, immune.

After the female has deposited her eggs, the grubs hatch and bore inside the timber, finally changing into beetles which cut "flight holes" and emerge, usually 10 to 12 months after the eggs were laid. In the southern states, the beetles emerge in the summer, although in heated rooms and in the northern states, the life cycle may be considerably reduced and the period of emergence extended.

The flight hole of the emerging beetle may be bored through the truewood of the hardwood, softwood, plywood, building boards, and even through materials such as sheet lead. An example of the damage caused to plywood by the lyctus is shown in Fig. 2.

It should be remembered that no sign of the damage is visible until the flight holes are made, by which time, in most cases, the damage is almost complete. However, lyctus is of little importance in Eucalypt house building timbers in Australia. It is found in these only in strips and edgings of sapwood, and the proportion of these in any structure is usually negligible.

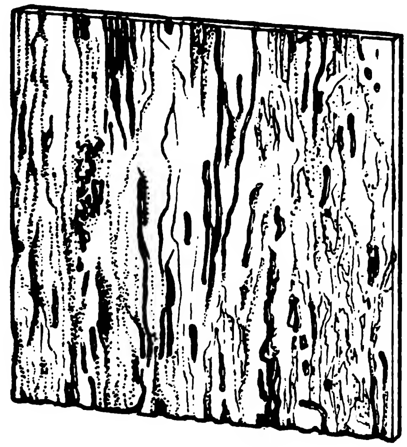


Fig.2 Example of Damage to Plywood by Lyctus.

In small sections, however, such as tiling battens, it can be serious. In highly stressed structures also, lyctus attack may be serious, firstly because of the reduction of useful sections, and secondly because of the danger of timber connector rings or shear plates being located in sapwood. Damage to furniture and ornamental work is usually important, owing to the unsightly effects produced.

The objections to lyctus in buildings are usually based on the fear of the infestation continuing to extend indefinitely, with ultimate failure, and to the danger of infesting furniture and other woodwork not showing signs of attack. As lyctus is extremely widespread, starch-containing sapwood, unless completely sealed by paint, varnish, etc., will be attacked within a year or two of installation, and any material so attacked can then be regarded as immune. The fears attendant upon the discovery of lyctus, particularly in structures, are therefore very largely unfounded.

Lyctus can be distinguished from anobium by the fact that the dust produced is smooth and floury when rubbed between finger and thumb.

(ii) <u>The Furniture Borer, or Anobium</u>. Anobium is fairly common in Australia, being second only to lyctus. It is a squat, dull brown beetle, about the same size as the lyctus. The anobium beetle is illustrated in Fig. 3.

The anobium infests softwoods, such as Baltic pine and New Zealand white pine, and some imported hardwoods. Sapwood, truewood, and heart are all attacked.

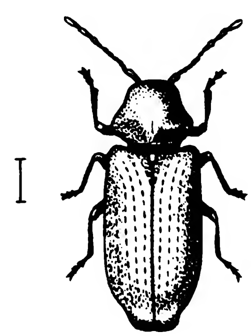


Fig.3 Furniture Borer, or Anobium.

Damage has rarely, if ever, been observed in Australian hardwoods, which are very resistant, if not immune, to anobium attack, and damage to Australian softwoods also appears to be rare.

The life cycle is similar to that of lyctus, but takes longer. The flight holes are slightly larger and the dust produced by the grub is gritty to the touch, when compared with that of lyctus. This difference between the dusts is an important distinguishing feature.

There is a belief that anobium attacks only old timber. The common occurrence of anobium in old timber appears to be due not to any preference for such timber, but to the slow rate of spread of the insect. Owing to its slow rate of spread, anobium does not find and attack new timber as rapidly as lyctus. Once established, however, thorough methods are needed to eradicate it.

(iii) Queensland Pine Beetle, or Calymmaderus. This insect is largely confined to Queensland where it attacks hoop pine, sometimes causing serious damage. It is similar in its habits and in the nature of the damage it causes, to the furniture borer (anobium).

(iv) Pinhole Borers. There are a number of different kinds of pinhole borers. They are all forest insects which attack trees or logs while they are green. Their holes afterwards appear in sawn timber. The insects die as the timber seasons. They are unable to attack seasoned timber.

The holes are usually less than $\frac{1}{8}$" in diameter, cleanly cut across the grain, dark stained, and free from dust. An example of the damage caused by pinhole borers is shown in Fig.4. These holes can be distinguished from those of lyctus and anobium by their straightness.

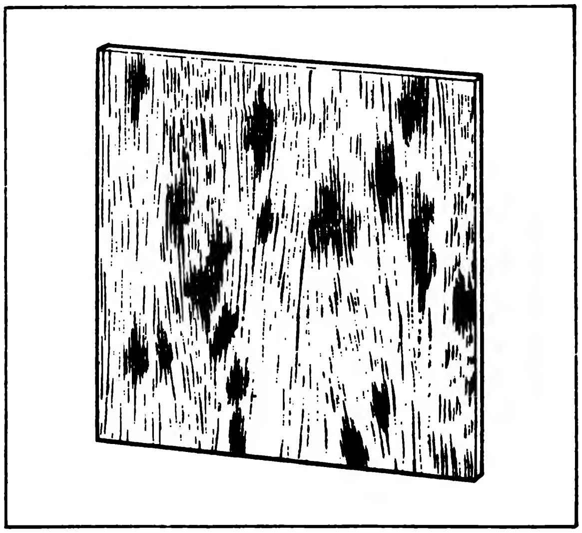


Fig.4 Damage Caused by Pinhole Borers.

An ordinary pin can usually be inserted into a pinhole up to the head, or nearly so. Lyctus and anobium holes bend about $\frac{1}{8}$" to $\frac{1}{4}$" below the surface. Pinholes in sawn timber are of no more importance than an equivalent number of n ail holes of the same size, except that where closely grouped, they are often associated with brittle material.

(iv) Other Borers. At rare intervals, other kinds of wood borers may be encountered. Most of these attack timber in the forest, either in the tree or in the green log. Subsequently the holes may be exposed when the timber is sawn or, if the insects are not discovered, they may complete their life cycle and emerge from seasoned timber, or even manufactured articles. None of these rare borers, however, can attack sound, seasoned timber in service. This is fortunate, for some of the rarer forms make isolated holes in trees up to 1" in diameter.

CONTROL OF BORERS.

Sometimes it is desirable or essential to control borer attack, or to eradicate borers completely from a piece of timber. Lyctus is commonly found in eucalypt building scantling and it has already been pointed out that such damage is usually negligible, and that under these circumstances no treatment is necessary. Where lyctus or anobium damage requires attention, however, the insects can be eradicated by fumigation carried out under guarantee by a competent operator, or by injecting the flight holes with a solution 5% of para dichlorbenzene in kerosene with a syringe. Equal portions of kerosene and turpentine also make a satisfactory treating solution. These treatments also apply to the Queensland pine beetle. Sapwood can be proofed against lyctus by impregnation with boric acid. It should be noted that an impregnation, not a surface treatment, is necessary. Pinholes and other types of borer damage require no treatment.

SECTION 8. TERMITES

DESCRIPTION AND OCCURRENCE.

Termites, or white ants, are small insects, usually under half an inch in length, with soft bodies and horny dark coloured heads. They destroy large quantities of timber annually in Australia, attacking poles, posts, sleepers, and wooden structures of all kinds.

Australia has about 200 kinds of termites. They are found in every state but are more common in the northern part of the continent. Only a few are destructive, but some of these are widespread and numerous. The presence or absence of destructive termites in any locality can only be established by reference to responsible authorities.

ORGANISATION OF TERMITE COLONY.

Termites live in groups called colonies. Some colonies contain a few hundred termites, others may contain more than a million.

Each colony makes a nest, either by hollowing out portion of a standing or fallen tree, or by building a specially designed structure out of masticated vegetable material and earth. This may be completely underground or may form a mound above the surface, as shown in Fig. 1. In northern and central Australia they may reach 20 ft. or more in height, but in southern Australia they are usually about 3 ft. high.

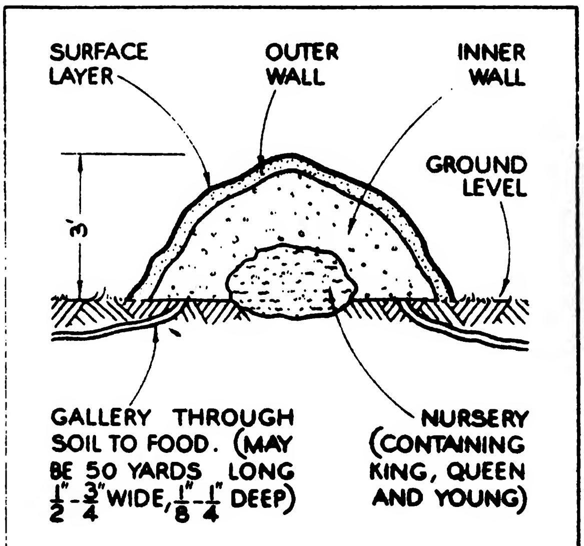


Fig.1 Termite Nest Above the Ground.

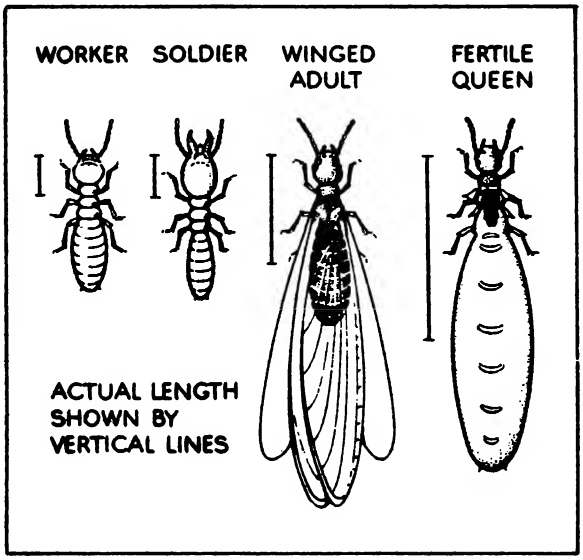


Fig.2 Types or 'Castes' of Termites.

Termites eat wood, grass, and other vegetable material containing cellulose, which is their principal food. Some live almost entirely on wood, whilst others are mainly grass feeders. They will attack many other substances, including bitumen and lead.

Each colony is produced by one male and one female termite, called the king and queen respectively. The queen may, over a period of years, lay more than 1,000,000 eggs. From these eggs special types of termites, called castes, are developed, which are illustrated in Fig. 2.

TYPES OR 'CASTES' OF TERMITES.

(a) Worker Caste. Termites of the worker caste are sexless, wingless and blind, with short powerful jaws. They build the nest, obtain and digest the food, feed all the other individuals in the colony, and tend the queen, eggs and young.

(b) Soldier Caste. Termites of the soldier caste are sexless, wingless and blind, with big jaws or poison glands or both. They defend the colony against intruders such as true ants.

(c) Winged Caste. Winged male and female termites are produced with dark coloured bodies, proper compound eyes, fully developed sex organs, and two pairs of long transparent wings. They leave the nest during the spring and summer, mate with each other, lose their wings, and if they survive, become new kings and queens and produce new colonies. Most of them are eaten by birds and other enemies.

(d) Subsidiary Queens. Special subsidiary queens may also be developed to maintain the supply of eggs for the colony. If the first queen dies, these carry on her duties.

DIVISION OF TERMITES ACCORDING TO NESTING HABITS.

Termites may be divided, for purposes of control, into two groups :-

(i) Termites that nest and live in trees, and do not generally touch the ground. These are forest insects which hollow out forest trees, but except on rare occasions, do not damage seasoned timber.

(ii) Termites that nest and live in the soil. These include all the termites which damage timber in service. They must maintain contact with the ground. A typical nest is illustrated in Fig.3.

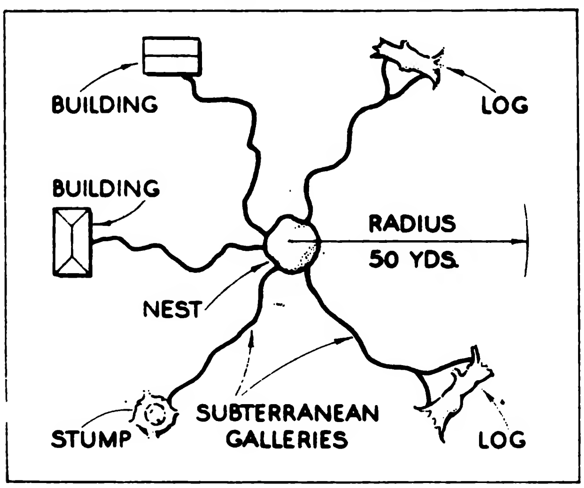


Fig.3 Plan of Typical Termite Nest.

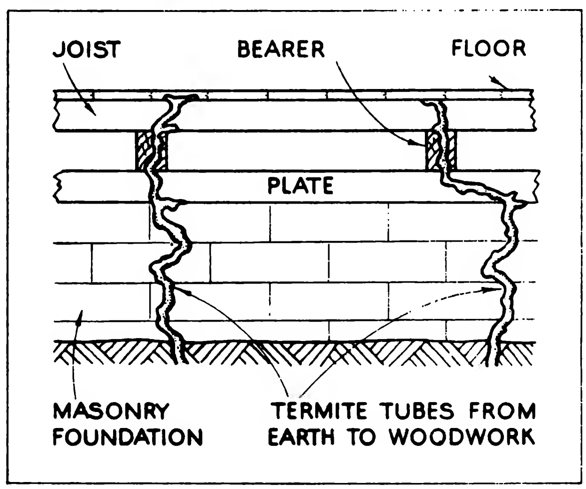


Fig.4 Earthen Tubes Built by Termites.

Practically all damage to seasoned timber is caused by soil-nesting termites. Timber in contact with soil is therefore most readily attacked. To reach timber not in contact with the ground without exposing themselves, termites frequently build earthen tubes, $\frac{1}{4}$" to $\frac{3}{8}$" diameter, for many feet over masonry or metal, as shown in Fig.4. Termites rarely expose themselves, so damage may not be observed until apparently sound timber breaks.

STRUCTURAL METHODS FOR PREVENTION OF TERMITE ATTACK.

(i) Termite Shields made from sheets or strips of 26 gauge galvanised iron or copper may be used as follows :-

(a) Sheets, called Caps, are placed on top of the stumps under the bearers, as shown in Fig.5. They may be fastened by nailing but care must be taken not to split the cap. Before nailing the cap, the top of the stump should be swabbed with creosote oil

To avoid nailing through the cap, a special type of cap may be used with a hoop iron strap soldered to each face. These straps are nailed to the bearer and stump respectively. In northern Australia bearers are usually fastened to the stump by a bent bolt passing round the cap. Termites, for some unknown reason, do not readily climb the bolt.

(b) Strips are placed on the inside of foundation walls, as shown in Fig.6. They must be continuous, and should be grouted into the walls. They should also be applied to the outside of the walls where this is not easily inspected.

Caps and sheets must project at least 2 inches beyond the edge of the stump or wall with the projecting lip inclined downwards at an angle of 45°.

Termite shields may be rendered useless by heaps of rubbish touching the bearers, or by unprotected trellises, outhouses, drainpipes, steps, etc. which provide the termites with a path between the ground and the portion of the building above the caps. All such structures must be protected with suitable shields, or else separated from the main building. There must be a clearance of at least 12" between the bearers and the ground.

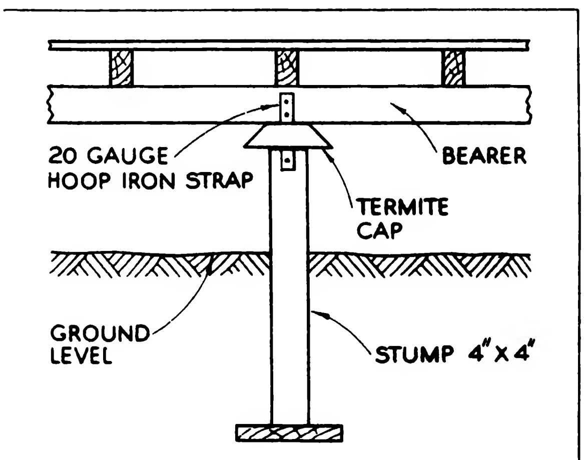


Fig.5 Prevention of Termite Attack by Caps.

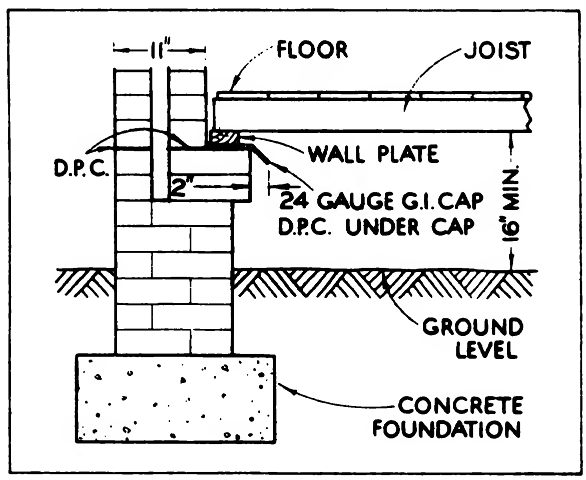


Fig.6 Prevention of Termite Attack by Strips.

(ii) Solid Concrete Floors. Wooden structures placed on solid concrete floors receive excellent protection from termites, provided that the concrete floor is raised some inches above ground level and that it projects at least 2 inches all round the building. All construction joints are poisoned with creosote or filled with bitumen containing 1.0% white arsenic.

Regular inspections are essential with this type of floor to detect termite tubes over the concrete.

PREVENTION OF TERMITE ATTACK BY USE OF CHEMICAL SUBSTANCES.

Timber placed in contact with the soil, or on foundations without termite shields, can be made resistant to termites by painting with creosote oil, and in the case of stumps or foundations, puddling the soil around them to a depth of one foot with the same material, to form a layer 2" thick of treated soil. This protection is temporary and may cease in a year or two under severe exposure. Under a floor it may last longer.

ERADICATION OF TERMITES.

When termites are discovered in a wooden structure it is important to destroy the whole colony if possible.

The following method is useful, though it may not always succeed, and depends for its success largely upon the skill of the operator.

Locate the termite tubes or the galleries in the wood, gently open them, and blow in 1/10 oz. of finely powdered white arsenic, as shown in Fig. 7, and seal immediately.

If the treatment is successful, the termites will continue to move in the tubes and galleries, pick up the arsenic on their legs and bodies and pass it on to one another until finally the entire colony is killed.

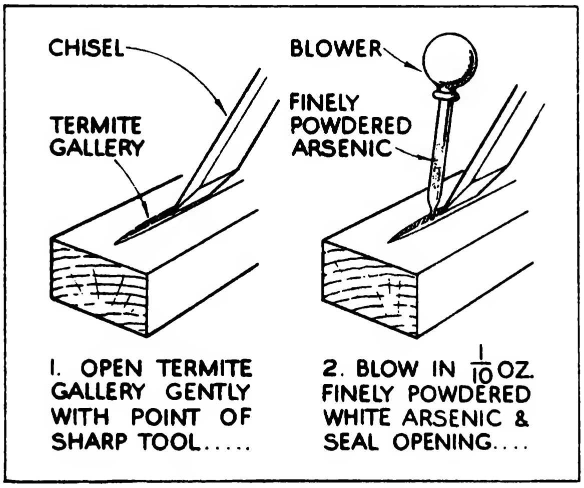


Fig.7 Method of Eradicating Termites in Timber.

If this method of termite eradication proves unsuccessful, or is undesirable, the following procedure may be adopted.

(a) Trace the termites back to the soil and break any communication tubes.
(b) Puddle the soil and paint the foundations, as described above, with creosote oil, at the point of emergence from the soil.
(c) Remove any harmful structures giving the termites access to the building if these are present.
(d) If structures cannot be removed, apply creosote at point or points of contact with the building.

When these measures have been taken effectively, any termites left in the building will die out.

TIMBER RESISTANT TO TERMITE ATTACK.

Timbers which resist decay are usually resistant to termite attack. Any very durable timber therefore, can be considered reasonably immune from termite attack. White cypress pine which contains certain chemicals, is one of the most termite resistant timbers in Australia and is commonly used in many inland areas for building construction for this reason.

Firewood or sawn timber containing termites will not, except in very rare cases, infest other timber. The termites in the timber will die out.

AUSTRALIAN TIMBERS.

Some Australian timbers which are in common use are given in the following list :-

RED GUM:

Description. Colour is red. Heavy in weight, its close curly texture gives it hardness. It is very durable when in contact with the ground, and resistant to some insect pests. It effectively stands great weight on the end grain, but does not reliably stand cross grain shocks.

Sizes. Red gum is available in square sections, used as stumps or posts, and in planks, used for window sills, sole plates, steps, and other exterior work where durability is required. It is not cut in long lengths.

Habitat. Queensland, New South Wales, Victoria, and South Australia.

JARRAH:

Description. Colour is reddish brown, darkening to real brown. Heavy in weight, it has close grain, straighter than the grain of red gum, and is almost as hard. It is very durable in contact with the ground, resists some pests, stands weight both ways of the grain, and is not easily broken across the grain. Because of its fire-resisting quality and durability, it is used for exterior and interior fire escape stairs. Jarrah is a timber with many uses.

Sizes. Jarrah is available in square sections, planks, scantlings, weatherboards, tongue and groove flooring boards, and joinery. It is cut in lengths up to 30 feet.

Habitat. Western Australia.

KARRI:

Description. Colour is reddish brown. Heavy in weight, its grain varies from straight to wavy. It is not durable in the ground, but it is strong and tough. Not so common in eastern states as jarrah.

Sizes. Karri is available in large planks and scantlings.

Habitat. Western Australia.

HARDWOOD.

The name "hardwood" is applied in general to cover several varieties of Australian eucalypts, such as red ash, woolly butt, stringy bark, mountain ash, and messmate. There is so close a resemblance amongst these varieties after milling, that only those who have studied timber very closely are able to express a decided opinion as to the name of one selected sample board. Some characteristics in any one of these eucalyptus timbers may be outstanding, but all come on to the building site with one title, hardwood.

Description. Colour, when newly cut, varies from light oak through shades of yellow, light pink, and light brown. Exposed to the weather, it quickly becomes a common grey. Grain is straight, even and tough, which makes hardwood timber of great use in constructional work.

Sizes. Hardwood is available in building scantlings up to 20 feet long. When larger pieces are required they must be ordered in advance. Fencing palings are sawn or split whilst unseasoned. At the saw mill the most suitable timber is cut into planks and boards for seasoning and for conversion into weatherboards, tongue and groove flooring, and lining.

Habitat. Queensland, New South Wales, Victoria, Tasmania, and South Australia.

KING WILLIAM PINE (King Billy).

Description. Colour is reddish when freshly cut, fading to pale pink when exposed to air. Light in weight and not very strong, it is easy to work and is seasoned readily.

Sizes. King William pine is available in medium widths, and in joinery sizes.

Habitat. Tasmania.

PINUS RADIATA.

Description. Colour is light yellow with darker yellow and light brown lines of grain. Coarse in figure, it frequently has dark brown knots. It is light to medium in weight, and seasons readily, but is very liable to twist. It is soft and brittle, and is used for internal fittings and concrete forms.

Sizes. Pinus radiata is available in narrow widths, weatherboards, flooring and lining.

Habitat. South Australia, and Victoria.

HOOP PINE.

Description. Colour is yellow to light brown. It is generally straight, even grained, and easy to work. Medium in weight, heavier boards are easily split along the grain. Seasoned material is quickly affected by changes in climate.

Sizes. Hoop pine is available in manufactured plywoods, mouldings, planks and wide boards. It is used for draining boards, shelving, cupboards and joinery.

Habitat. Queensland, and New South Wales.

KAURI.

Description. Colour is pale yellow to light brown. Grain is straight and even. It is soft, medium in weight, and seasons slowly. In changes of humidity, its length varies considerably. It shows very little figure in grain, is easy to work along the grain, and is cheesy to cut across the grain.

Sizes. Kauri is available in manufactured plywood, planks and wide boards. It is used for shelving, cupboards, and joinery.

Habitat. North Queensland.

MYRTLE.

Description. Colour is pink to pinkish brown. Fine and close in grain, it is moderately hard and is medium heavy weight. It shows a tendency to twist and is difficult to season. It cuts with a clean face , and works well. It has good wearing surface.

Sizes. Myrtle is available in manufactured plywood, medium width planks, and boards. It is used for window sills and flooring.

Habitat. Tasmania.

CELERY-TOP PINE.

Description. Colour is white to yellow and light brown. Straight in grain, it is moderately hard and almost light in weight. It is difficult to season and twists readily.

Sizes. Celery-top pine is available in small sizes with short lengths, and in tongue and groove flooring.

Habitat. Tasmania.

CYPRESS PINE (White).

Description. Colour is light brown, streaked with dark brown and with frequent knots. It has a characteristic odour, and resists insect pests. It cuts well and is very brittle.

Sizes. Cypress pine is available only in small sizes, and is used especially in places infested with termites, for structures, weatherboards, tongue and groove flooring, and lining.

Habitat. Victoria, and New South Wales.

HUON PINE.

Description. Colour is pale yellow to yellowish brown. Grain is straight, fine and close.

Sizes. Sizes of Huon pine are limited. It is used in joinery.

Habitat. Tasmania.

IMPORTED TIMBERS.

The following are some of the timbers which are imported from other countries :-

OREGON (Douglas Fir).

Description. Colour is yellow to reddish brown, with prominent growth rings in the grain. Light in weight and reasonably strong, it is easy to work and very useful. Imported in flitches, squares, and plywood, this timber is extensively used in structural work, concrete forms, and joinery, when it is available.

Sizes. Sizes are cut to thickness as required, and up to 18" in width. Building scantlings are available up to 40 feet in length.

Habitat. Canada, and U.S.A.

RED PINE (Red or Californian Pine).

Description. Colour is light red to reddish brown, generally darkening when exposed to air. Medium in weight, it is not used in positions where strength is necessary. A seasoned softwood that is easy to work and is remarkably durable.

Sizes. Red pine is available in very wide boards and joinery sizes.

Habitat. U.S.A.

BALTIC DEALS.

Description. White deal is pale yellow with light brown knots. Red deal is yellow with red and brown knots. Deal is medium in weight, and seasons readily. White deal is more liable to twist than red deal.

Sizes. Baltic deals are available in milled weatherboards, flooring, and lining.

Habitat. Baltic states and northern Asia.

ROUGH SAWN TIMBER.

Round logs are cut at the saw mills into marketable sizes, and stacked in the timber yard to await sales orders.

In cutting timber from a log, far more consideration is given to the amount of timber that can be cut from the log than to the direction in which the grain of the timber will run. This latter point, however, is important in seasoning, and also in timbers needed for fine work.

The size of a piece of timber does not indicate the purpose for which it is most suitable. The illustrations on the opposite page indicate the part of the log from which timber to be used for special purposes should be cut.

FLITCHES from the mill become heavy beams or bressummers in the building. They are fixed on edge to carry heavy loads. The size and kind of timber is specified by the designer.

SCANTLINGS are used for bearers or small beams. They bridge over openings or span between supports. The size of the section used is calculated in relation to the width of the opening or span and the load to be carried.

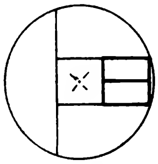
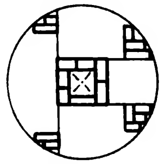
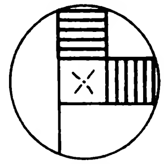
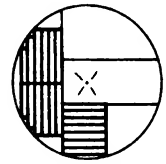
BIG PLANKS of hardwood or oregon are suitable for floor joists for the first floor, or for hanging beams that hold up the weight of the ceilings. The ceiling joists are held up to the hanging beams by hanging fillets.

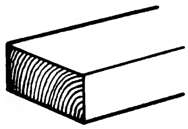
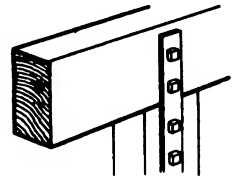
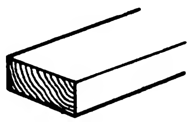
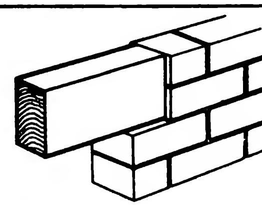
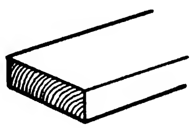
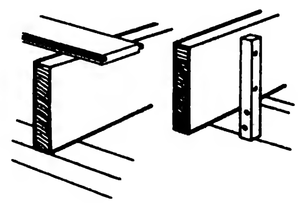
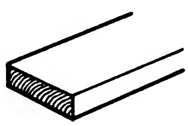
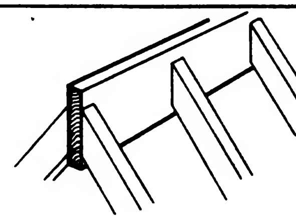
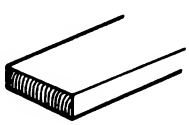
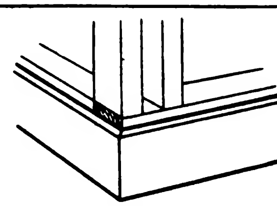
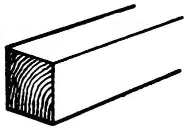
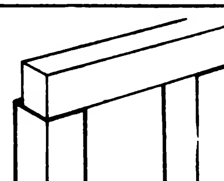
WIDE BOARDS become ridges in roof framing, where they make fixing for the heads of the rafters, enabling the rafters to be spaced out properly and to finish up to the correct height line.

DRESSED BOARDS are used to form plinths at the base of walls. They are made in good durable timber, especially when they come in contact with the soil. Several widths may be necessary to enclose the foundations between ground and floor. All boards that will be painted are better dressed, i.e., planed up either by machines or by hand.

SQUARES have width and thickness of equal size. They are used as stumps or storey posts to stand upright and support heavy loads. They are made square so that they will not collapse towards one side more easily than towards another.

USES OF TIMBER IN BUILDING

 FLITCHES	 SCANTLINGS	 PLANKS	 BOARDS

TIMBER YARD TERMS		TYPICAL POSITION	
FLITCH OVER 4″ THICK OVER 6″ WIDE		LEVEL BEAM OR BRESSUMMER TO CARRY HEAVY WEIGHTS	
SCANTLING $1\frac{1}{2}$″ TO 4″ THICK UP TO 6″ WIDE		BEAM OVER AN OPENING	
PLANK $1\frac{1}{2}$″ TO 4″ THICK OVER 6″ WIDE		FLOOR JOIST AND HANGING BEAM IN CEILING	
BOARD $\frac{3}{4}$″ TO $1\frac{1}{2}$″ THICK OVER 3″ WIDE		ROOFING RIDGE	
BOARD $\frac{3}{4}$″ TO $1\frac{1}{2}$″ THICK OVER 3″ WIDE		WALL PLINTH	
SQUARE FROM $1\frac{1}{2}$″ x $1\frac{1}{2}$″ UP TO 6″ x 6″		STOREY POST OR STUMP	

SCANTLING is the name used to cover timber in a variety of sizes, that is cut as stock to be used in structural building work. It is sometimes referred to as "quartering". It may be cut in the bush mill straight from the log, or may be recut from flitches or big squares. Circular saws and recut band saws are utilised in breaking down the sizes.

SMALL SCANTLINGS are used in the wall framing of timber buildings and in the roofs, and floor construction of ground floors in residences. The most common width is 4". This is one of the standard dimensions in walls, floors and ceilings. The second dimension of the timber section is made thicker or thinner, as the position requires.

BOARDS of approximately 1" thickness have a great number of uses. Large quantities are used in making forms and decking for concrete. Their light weight allows them to be easily handled and fixed. Temporary woodwork of this kind is commonly re-used several times, in order to economise on its first cost.

BIG BATTENS of good size section are necessarily used for holding the heavy gauge nails required when fixing corrugated "roofing", whether iron or cement. A common size is 3" x $1\frac{1}{2}$". The widest spacing of both the battens and the rafters under them is 3 feet. When the rafters are given wider spacing the section size of the batten must be increased and it is then referred to as a purlin, not as a batten.

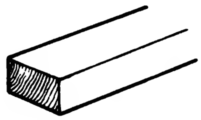
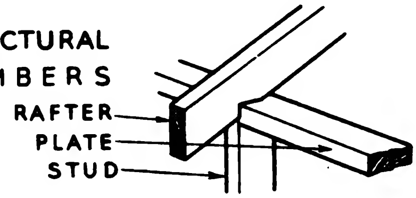
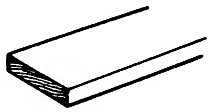
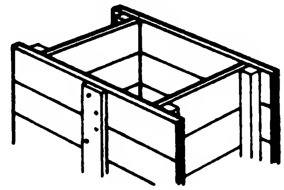
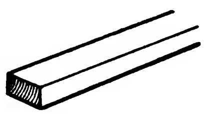
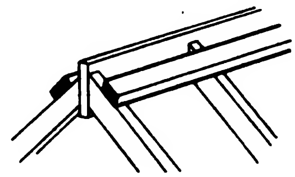
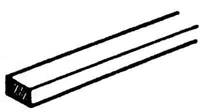
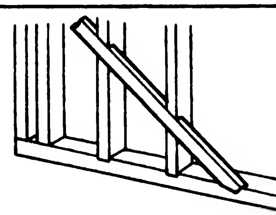
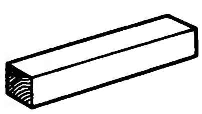
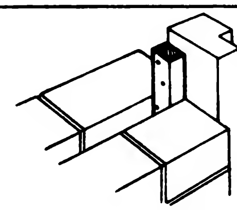
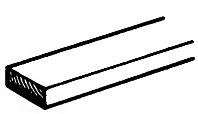
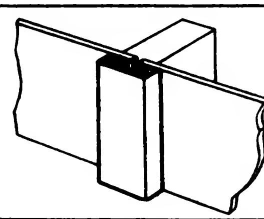
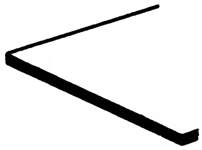
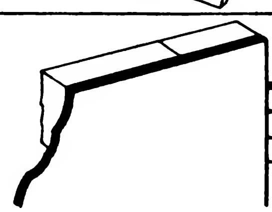
SMALL BATTENS are strong enough to make braces in timber framed walls of residences as these do not have great heights and widely spaced studs. The braces are usually placed on the outer sides of the walls where they can be easily nailed into the studs and plates when the wall is plumbed in its upright position.

OFF CUTS are the small odd sized pieces that come off when boards are cut down to size. They make short fillets to fix door and window frames into surrounding brick walls.

COVER STRIPS may be either square or moulded by machines at the mill. They cover the joints in vertical sheeting or other abutting materials. The term is applied only to small size stuff.

THREE PLY is made up of thin layers of thin veneer or heavier timber. The grain of the centre layer runs across the grain of the other two, and the three are well glued together. It is used for wide panels in doors, walls, back of cupboards, and similar purposes.

USES OF TIMBER IN BUILDING

TIMBER YARD TERMS	TYPICAL POSITION
SCANTLING $1\frac{1}{2}''$ TO $4''$ THICK UNDER $6''$ WIDE 	STRUCTURAL MEMBERS 
BOARD $\frac{3}{4}''$ TO $1\frac{1}{2}''$ THICK OVER $3''$ WIDE 	CONCRETE FORM 
BATTEN $\frac{5}{8}''$ TO $1\frac{1}{4}''$ THICK $1''$ TO $3''$ WIDE 	ROOF BATTEN 
BATTEN $\frac{5}{8}''$ TO $1\frac{1}{4}''$ THICK $1''$ TO $3''$ WIDE 	DIAGONAL BRACE 
OFFCUT MISCELLANEOUS SIZES 	FILLET TO HOLD FRAME 
COVER STRIP FROM $1\frac{1}{2}'' \times \frac{3}{8}''$ TO $3'' \times \frac{3}{4}''$ HARDWOOD, RED PINE OR OREGON 	COVER STRIP OVER JOINT 
3 PLY $\frac{5}{64}''$ TO $\frac{3}{8}''$ THICK $4' \times 3'$ TO $7' \times 4'$ PLAIN OR FIGURED 	DOOR PANEL 

MILLED TIMBER.

Timber that is specially prepared to shape for a single purpose by machining at the source of supply is commonly referred to as "milled". Practically all the timber that is visible when a building is finished has been milled.

FLOORING is generally dressed on both sides and the edges are made with tongues and grooves so that when a number are put together they will maintain an even surface, not only immediately over the joists where they are nailed, but also along their lengths between the joists. Joints in well milled flooring will not creak when weight is applied to single boards in the unsupported part between joists.

TONGUED AND GROOVED LINING BOARDS are used for interior wall covering and are more durable than plaster sheets, especially where they will be subjected to hard knocks from furniture. When fixed vertically, special battens or nogging must be provided for fixing the boards. In order to obscure the joints, some are run with a chamfered edge in addition to the tongue and groove. This makes a vee joint between boards.

Tongued and grooved lining boards are also run with beaded edges to form breaks at their junctions. Lining boards require these breaks because they are used on walls and soffits where they cannot be flushed off with the sand-papering machine in the same way as flooring boards, which are lying flat.

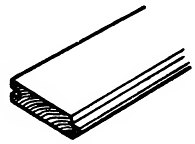
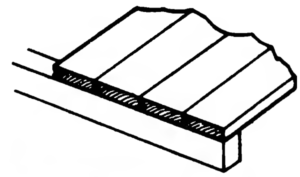
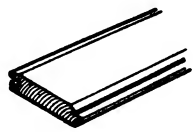
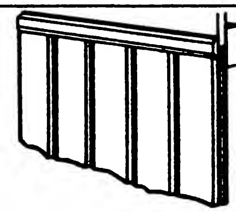
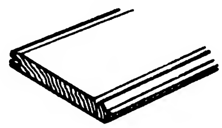
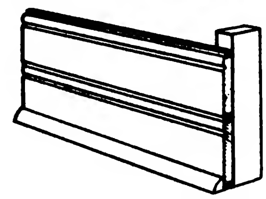
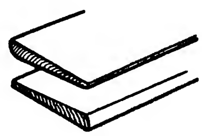
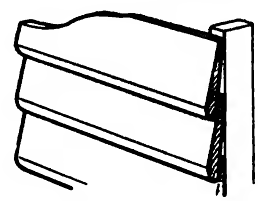
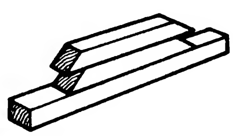
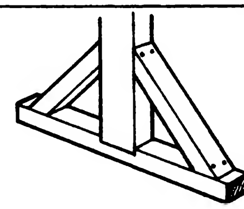
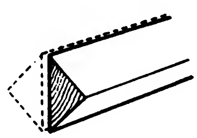
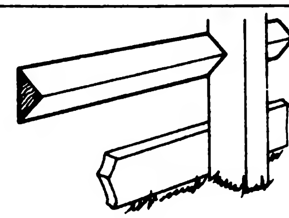
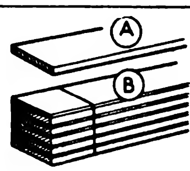
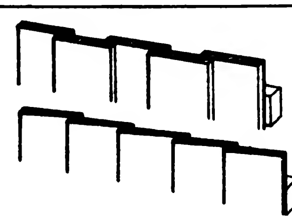
WEATHERBOARDS are used on walls that are exposed to weather. An overlapping edge gives them room to swell and shrink in width without damage, as atmospheric conditions change. Weatherboards are run with square edges or round edges.

SOLES AND STRUTS are cross cut at the mill on the circular saw so that fencing work can be carried out quickly. A set of three pieces, comprising one sole piece and two struts, is necessary for every post.

ANGLE RAILS do not provide a lodging place for rain and usually prove longer lasting than those with flat top edges. They are cut diagonally from square timber at the mill.

PALINGS may be either split or sawn to size. Split palings always have tapered sections; sawn palings may be either tapered or parallel in thickness. Two ways of fixing palings are shown. The lower one is always used for split palings. The upper one is an alternative that is suitable for sawn palings that are not tapered in thickness.

USES OF TIMBER IN BUILDING

TIMBER YARD TERMS		TYPICAL POSITION	
$\frac{3}{4}$" FLOORING WIDTH PINUS RADIATA 6" HARDWOOD $4\frac{1}{4}$" JARRAH $3\frac{1}{2}$"		FLOOR COVERING	
T. & G. LINING V JOINTED $\frac{1}{2}$" AND $\frac{5}{8}$" THICK $3\frac{1}{2}$" AND 4" WIDE		WALL DADO	
T & G LINING BEADED $\frac{1}{2}$" THICK 6" WIDE		INTERIOR WALL LINING	
WEATHERBOARDS TAPER $\frac{3}{4}$" TO $\frac{1}{4}$" 7" WIDE		EXTERIOR WALL COVERING	
3" x 2" SOLE & STRUTS OBTAINABLE IN STANDARD SETS		FOOT OF FENCE POST	
ANGLE RAIL 2 OUT OF 4" x 4"		FENCING RAIL	
PALINGS (A) SAWN 6" x $\frac{1}{2}$" (B) SPLIT 7" WIDE TAPER $\frac{7}{8}$" TO $\frac{1}{4}$"		FENCE COVERING	

MOULDINGS are milled to standard shapes and sizes from planks or boards that have been sawn to the regular sizes of 1", $1\frac{1}{4}$", $1\frac{1}{2}$" and 2" etc. They come from the moulding machines in smaller actual dimensions than the original sawn material but many of them retain the nominal size of the sawn material. With the exception of beads, they commonly finish $\frac{1}{8}$" less than the nominal size in small mouldings and $\frac{1}{4}$" less in large ones.

The mouldings form finishing pieces in angles, around openings in walls and make dividing pieces between one fitting and another. Typical positions are shown in the illustrations on opposite page, but many other positions where they are used can easily be found.

QUARTER ROUND, frequently abbreviated to "quad", is used in many angles where a very close joint is difficult to make or to maintain. It is the moulding most commonly used.

SCOTIA is the common name applied to a shape which is strictly speaking "cavetto". This latter name is rarely used. The scotia moulding is frequently seen in the position illustrated. It is nailed in line before the spouting is fixed and guides the fall towards the drainage outlets.

OVOLO moulding has in part a resemblance to the quarter round but has the additional squares at the top and the bottom which make quirk lines to relieve the bold look that a plain round mould gives.

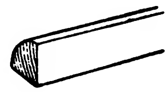
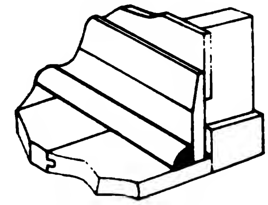
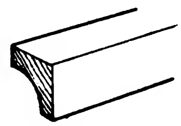
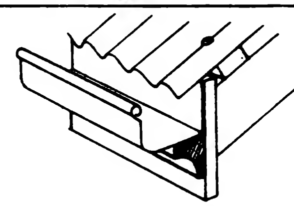
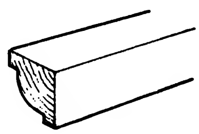
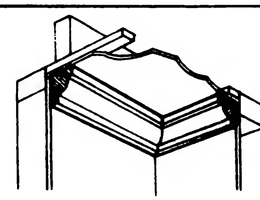
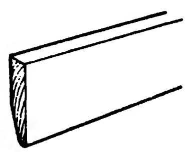
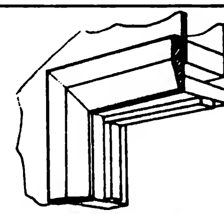
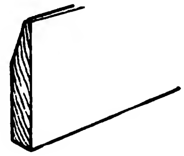
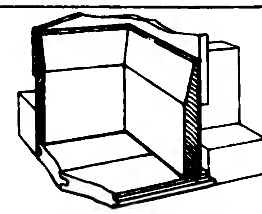
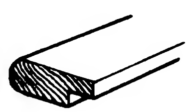
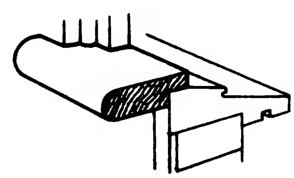
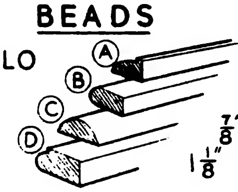
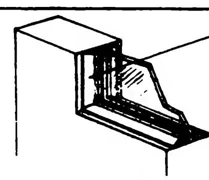
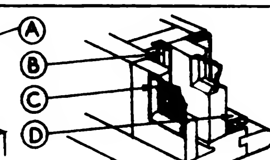
ARCHITRAVES are moulded in a variety of shapes. The main object in using moulds instead of plain square material around a wall opening is to improve the appearance and also to remove much of the thickness which is a disadvantage when hinged doors are opened to more than 90°.

SKIRTING is fixed on the walls close to the floor to give protection to the more fragile plaster sheeting or rendering which would be damaged by continuous knocks from brooms, heels and toes of chair legs, and personal footwear.

WINDOW NOSING is made in the shape illustrated, or with a tongue on its inside edge that will fit into a groove in the window sill. The width of the nosing is made to suit the position of the window frame in the thickness of the wall. It forms a cover to the top edge of the wall sheeting and a stop for the bottom end of the architrave.

BEAD is the name applied to almost any thin strip with a rounded edge. Part ovolo beads are used to hold glass in place in doors or windows. Their shape is made to match the solid moulded edge on the other side of the rebate. Parting beads keep the top and bottom sashes apart in box frames and with the staff beads, they help to form running grooves for the sashes. The fly wire bead is used to cover the edges of the wire on both door and window screens.

USES OF TIMBER IN BUILDING

TIMBER MOULDINGS	TYPICAL POSITION
QUARTER ROUND FROM $\frac{1}{2}$" TO $2\frac{1}{2}$" RADIUS 	JUNCTION OF FLOOR AND WALL 
SCOTIA FROM $\frac{7}{8}$" TO 2" 	SEAT FOR SPOUTING 
OVOLO FROM 1" TO 3" 	CORNICE AT WALL AND CEILING 
ARCHITRAVE FROM 3" x $\frac{3}{4}$" TO 5" x $1\frac{1}{8}$" 	JUNCTION OF WALL AND FRAME 
SKIRTING FROM 4" x $\frac{3}{4}$" TO 7" x $\frac{7}{8}$" 	JUNCTION OF FLOOR AND WALL 
WINDOW NOSING FROM 2" x $1\frac{1}{2}$" TO 4" x $1\frac{1}{2}$" TIMBER TO MATCH FRAME 	JUNCTION OF SILL AND WALL 
BEADS PART OVOLO — $\frac{5}{8}$" x $\frac{5}{16}$" PARTING — $\frac{7}{8}$" x $\frac{3}{8}$" FLY WIRE — $\frac{7}{8}$" x $\frac{3}{8}$" STAFF — $1\frac{1}{8}$" x $\frac{5}{8}$" 	 GLAZING  SCREEN & WINDOW

TYPES OF GLUE.

The gluing of wood has been practised for thousands of years. Glued wooden articles constructed by the early Egyptians around 2,000 B.C., are still in existence. In recent times many new glues and gluing methods have been discovered, but the adhesives and techniques as developed by the early craftsmen still find application today. Animal glue (hide glue) and casein glue are the two types most commonly used.

(a) Animal Glue. This is prepared by cooking the hides, bones, skin, trimmings, etc., of animals, in water, then concentrating and drying the liquor so obtained. Different grades of animal glue are available, for example, Russian glue, match glue, cabinet glue, joiners' glue, and box glue. Each grade is supplied in a number of different forms, for example, sheet, kibbled, diamond, pearl, and powdered glue, depending on the size of the particle. The finer grades can be prepared for use more rapidly than the sheet glue, and in addition, possess the advantage that they can be blended to conform more closely to recognised standards.

Animal glue is commonly marketed in Australia in the pearl form. Animal glue is sold also in semi-liquid and liquid forms. The semi-liquid glues are prepared for use by simply melting and bringing to the required temperature. No water is added.

The chief advantages and disadvantages of animal glue are as follows:-

Advantages.	Disadvantages.
(i) High joint strength.	(i) Hot application.
(ii) Quick setting.	(ii) Little or no water resistance.
(iii) Freedom from stain.	

(b) Casein Glue. Casein, the basic raw ingredient, is obtained by the souring of skim milk. After precipitation it is washed, dried and ground. The glue is marketed as a dry powder comprising casein mixed with various chemicals. It is prepared for use by mixing with cold water. The glue sets by chemical action as well as by absorption of water by the wood. Once set, it cannot be re-melted for use.

The advantages and disadvantages of casein glue are as follows:-

Advantages.	Disadvantages.
(i) High Strength.	(i) Tendency to stain some timbers.
(ii) Cold application and thus long assembly time.	(ii) Slower setting than animal glue, with lack of initial "grip" for joinery work.
(iii) Fairly high water resistance.	

(c) Liquid Glues, frequently referred to as "fish glues". These have found application in the past, mainly for small gluing jobs and repair work. They are supplied ready for use. The bulk of liquid glue is now made, however, by the treatment of animal glue, and not from the heads, bones, trimmings, etc., of fish, as with the original liquid glues.

(d) Starch, Blood Albumen and Soya Bean Glues. These glues are not used for joinery work but find application overseas in large scale plywood and veneering operations.

(e) Synthetic Resin Glues. Phenol formaldehyde and urea formaldehyde resins are the two main types available. The phenol formaldehyde resins are thermosetting, requiring temperatures of 280 to 300 degrees F. to set the glue. The urea formaldehyde resins can be set either hot or cold, and are thus being used for certain classes of joinery work, e.g., boat building, etc. They are supplied usually as a liquid, to which a "hardener" is added immediately prior to use, although some ready mixed types to which water only need be added are available in U.S.A., and to a limited extent in Australia.

The advantages and disadvantages of synthetic resin glues are as follows:-

Advantages.	Disadvantages.
(i) High water resistance.	(i) Higher cost.
(ii) Immunity to bacterial or fungal attack.	(ii) High setting temperatures with some types.
(iii) Freedom from stain.	(iii) More precautions required to obtain successful results.

THE GLUING PROCESS.

Although gluing is regarded as being a rather rough and ready process, considerable skill and attention to detail is required to produce good joints consistently. Attention should be given to the following :-

(a) Preparation of joints.
(b) Preparation of Glue.
(c) Application of Glue.
(d) Application of Pressure.
(e) Duration of pressure and conditioning.

PREPARATION OF JOINTS.

The wood should be seasoned to an even moisture content so that movement due to shrinkage or swelling after gluing will be reduced to a minimum. There is no type of glue that will give permanent glue joints with green timber.

Joints should be machined smoothly and accurately to ensure close contact along the glued area. Uneven surfaces cannot make good contact when pressure is applied, and a weak and uneven glue line will result.

All surfaces to be glued should be clean and free from grease. Joints should be glued up as soon as possible after machining.

PREPARATION OF GLUE.

The various glue ingredients should be weighed and not measured. Use fresh water for mixing purposes, and keep all utensils, brushes, etc., scrupulously clean. Both animal glue and casein glue are liable to attack by putrefying bacteria and therefore absolute cleanliness must be observed.

(a) Preparation of Animal Glue. The proportions of glue and water vary with the grade of glue being used and the type of timber being glued. In general, however, joiners' glue is mixed with water in proportions varying from $1:1\frac{1}{2}$ to $1:2\frac{1}{4}$ by weight, while the range for cabinet glue is from $1:2$ to $1:2\frac{1}{4}$. The dry glue should be added to the cold water and allowed to soak 1 hour for diamond and pearl glue, 6 to 8 hours for kibbled glue, and 10 to 12 hours for sheet glue. It is then melted at a temperature not exceeding 150° Fahr. The temperature should be checked with a thermometer. When melting soaked glue, do not melt more than is necessary for immediate use. Always remember that excessive heating lowers the quality of the glue.

(b) Preparation of Casein Glue. The glue powder is added to cold water in proportions varying from $1:1\frac{1}{2}$ to $1:2\frac{1}{2}$ by weight. Small batches may be mixed by hand, but a mechanical mixer with rotating paddles is required for large scale work. To mix the glue, place approximately three-quarters of the water in the vessel or mixer. Add the glue powder to the water, stirring constantly. (Never pour water on to the glue powder.) Do not stir with a beating action as this causes the glue to foam. At first lumps may be formed but after several minutes the mixture should become smooth and creamy. Now add the remainder of the water and continue stirring for 5 to 10 minutes, after which the glue is ready for use.

Since casein glue contains caustic soda it should not be placed in contact with brass, copper, or aluminium. Iron, steel, earthenware, or enamel vessels should be used.

(c) Preparation of Urea Formaldehyde Glue (cold setting). Add the hardener, which is supplied as a powder or liquid, to the glue in the correct proportions by weight. Stir thoroughly (5 minutes should be adequate), after which the glue is ready for use.

Avoid the use of brass, copper or aluminium mixing vessels. Iron, steel, earthenware, or enamel vessels are satisfactory.

Various types of hardeners are in common use. Some types are applied as a brush or dip coating to one of the joining surfaces, while glue without the addition of hardener is applied to the other surface. The joint is made in the normal way. This is known as the "separate application method".

APPLICATION OF GLUE.

Glue may be spread by hand, with a brush, or by means of a mechanical spreader. Sufficient should be applied to ensure a slight "squeeze out" after the application of pressure. When spreading animal glue, the surfaces to be joined and the room temperature should preferably be between 70° and 75° F. Lower temperatures cause chilling of the glue and inferior joints, while high temperatures may cause "starved joints" and warping or twisting of the timber.

APPLICATION OF PRESSURE.

With animal glue, pressure should be applied fairly rapidly to prevent chilled joints. With casein glue more latitude is allowable, but as a general rule, the pressure should be applied within 15 minutes of commencing to spread the glue. This "assembly time" should be varied according to the temperature at the time of gluing. On hot days it should be reduced.

The pressure should be applied uniformly over the surface by means of suitable clamps or presses. In some cases, satisfactory "rubbed" joints can be made with animal glue. In a "rubbed" joint the surfaces to be joined are rubbed together to exclude air and excess glue. Positive pressure is not used. As a general rule, sufficient pressure should be applied to ensure intimate contact between the surfaces to be joined. This pressure may range from zero to 250 lb. per square inch.

DURATION OF PRESSURE AND CONDITIONING.

With animal glue, pressure should be maintained at least 1 hour for joint work and 3 to 4 hours when used for veneering. With casein glue the minimum is 4 hours, but longer times are preferable.

After the removal of pressure, joints should be conditioned (or cured) to complete the setting and allow the escape of moisture from the glue and the immediate vicinity of the glue line. Glued-up work should be placed in a well ventilated room with a good air circulation. Special rooms with a positive air circulation and control of temperature and humidity are recommended for large scale production.

COMMON GLUING DEFECTS.

Faulty glue joints may be due to a number of causes. The most common are given hereunder.

(a) Weak Joints as a result of Incomplete Contact.

(i) Improper machining of the pieces, e.g., uneven thickness, irregular surfaces, poorly fitting joints.

(ii) Wrong condition of the glue at time of pressing, e.g., dried or jellied glue, foamy glue, uneven glue spread.

(iii) Insufficient pressure, e.g., use of warped material, uneven application of pressure, unevenness of press plates or cauls.

(b) Weak Joints even though complete contact is obtained.

(i) Character of the glue, e.g., use of too weak a glue, too thin a glue mix, glue only partially dissolved.

(ii) Insufficient glue spread.

(iii) Starved joints caused by excessive heating of the wood (when using animal glue), too thin a glue mixture, too rapid clamping, the use of excessive pressure.

(iv) Pressing period too short.

(v) Oil, wax, or other material, on the wood.

(vi) Exposure of non-water-resistant glues to moisture.

(c) Weak Joints due to Improperly Dried Timber.

(i) The use of timber at too high or too low a moisture content, or at a non-uniform moisture content.

THE TWELVE LAWS OF GOOD GLUING PRACTICE.

1. Weigh the glue and measure the water.

2. See that the glue is well soaked before heating.

3. Use a clean sterile pan for mixing, and also use clean cold water.

4. Warm up and stir well till all is melted. The temperature should not exceed 160 degrees F.

5. Then turn down the steam till the temperature falls below 140 degrees F.

6. Don't fill the pots, but add more soaked glue from time to time.

7. Arrange in the afternoon that the pots are empty, or nearly empty, at the end of the day's work.

8. Clean out the pots and wash with boiling water ready for next day's melt.

9. Throw away the old glue or use it up where strength is of no importance.

10. If you need a higher temperature so as to spread the glue over a large surface without it chilling too quickly, heat in a separate bath just before use.

11. Do not use too viscous a mixture. Add more water so that you can keep the temperature down.

12. Finally, have a thermometer in the heating bath, and use it. Don't treat it as an ornament. It is the most essential part of your mixing plant.

CHOICE OF TOOLS.

The actual range and choice of tools depends mainly upon the type and class of work one expects to do. It varies, for instance, in carpentry as distinct from joinery or joinery fixing. There is also the matter of personal preference, and the importance of selecting and adapting the tools to suit the individual.

The carpenter and joiner uses a large variety of hand tools, and he should know their proper names, the purpose for which each is used, and how they are sharpened and kept in good condition.

Although most joinery is not generally made by hand methods nowadays, there are still many operations that must be done by hand. This is partly because it is still economical to do small jobs for which the setting up of a machine would be too great; partly because many operations have to be carried out away from the shop in which the machines are installed; and also because the machine takes no account of the individual fitting of parts. It is therefore necessary for the craftsman to have a good selection of tools and to know how to use and condition them.

CARE OF TOOLS.

It is important to keep tools correctly sharpened and in good condition all the time. Good workmanship is impossible with blunt or badly sharpened tools or with tools having broken or loose handles.

When using tools, "safety first" methods must always be used. The slipshod or casual use of sharp tools may result in serious accidents.

Cutting edges often lose their keen edges by accidentally or carelessly being brought into contact with metal. It is necessary therefore, to exercise great care when handling, packing or transporting tools, to guard them from injury.

Sharpness of planes and saws is readily lost when applied to timber with abrasive material adhering to it, such as soil, sand, cement and such like. Any timber that is dirty should be well brushed down before use.

When packing tools away, even for a short time, plane irons should be withdrawn from the cutting position. Chisels and saws should be kept away from hammers and try squares. Bits for boring should be rolled up in a duck bag or other container and not allowed to roll around loosely.

At all times keep metal parts dry. Frequently rub them over with heavy lubricating oil or grease, or animal fat that does not contain salt as preventatives against rust.

A foreman's first impression of a new hand is often gained by the look of the man's tools.

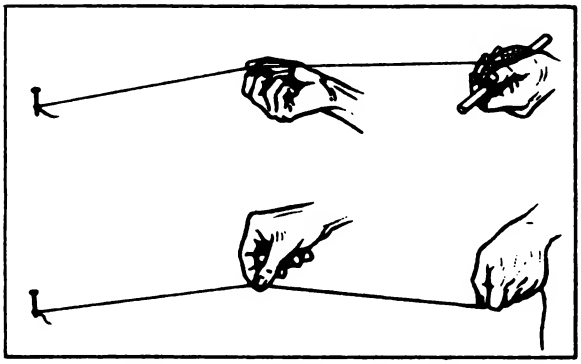


Fig.1 Chalking and Snapping the Chalk Line.

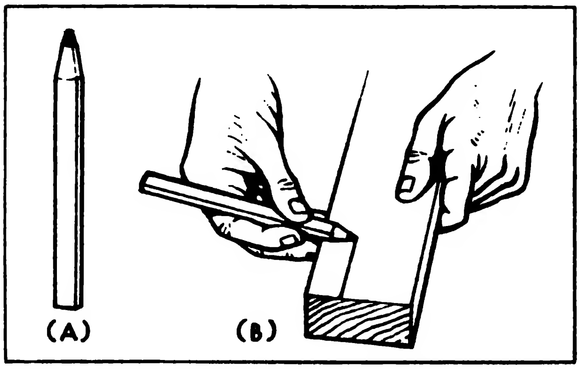


Fig.2 Finger Gauging with a Carpenter's Pencil.

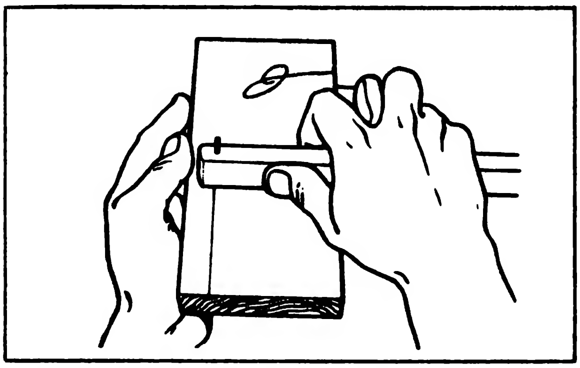


Fig.3 Method of Using the Marking Gauge.

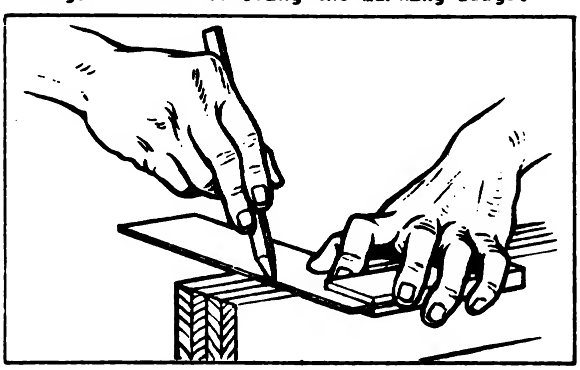


Fig.4 Squaring Lines with a Try Square.

THE CHALK LINE.

This is a strong white braided twisted cotton line, up to 50 feet long, which is wound on a stick or bobbin and is used for determining long straight lines. The method of chalking the line and snapping it is illustrated in Fig. 1. In performing this operation care must be taken to hold the line at the proper tension. When snapping the line, it should be lifted at right angles to the surface and released from the fingers.

THE PENCIL.

The carpenter's pencil, shown in Fig. 2A, is made with a large rectangular lead that will stand a great amount of wear. It is obtainable in hard and soft varieties. Hard ones are used on rough timber where an ordinary lead pencil would quickly break. Soft ones, or ordinary pencils, may be used for layout work on smooth timber. The method of finger gauging a line for a chamfer is shown in Fig. 2B.

MARKING GAUGE.

The marking gauge is used to accurately scratch a line parallel with the edge of a piece of timber. The point of the gauge must be kept sharp and should not project far from the beam which holds it. When using the gauge, mark a gauge line by pushing the gauge along the board so that the pin is visible while it is making the line, as illustrated in Fig. 3.

TRY SQUARE.

The try square is used as a layout tool for squaring lines across a piece of timber. Some try squares have a 45° shoulder at the intersection of the handle and blade for marking 45° cuts on boards. Fig. 4 illustrates an application of the try square in marking duplicate parts.

TRY SQUARE.

The try square is also used as a testing tool to test the surface of a board for straightness as shown in Fig. 1A, or to test the edge of a piece of timber to see that it is square, as shown in Fig. 1B.

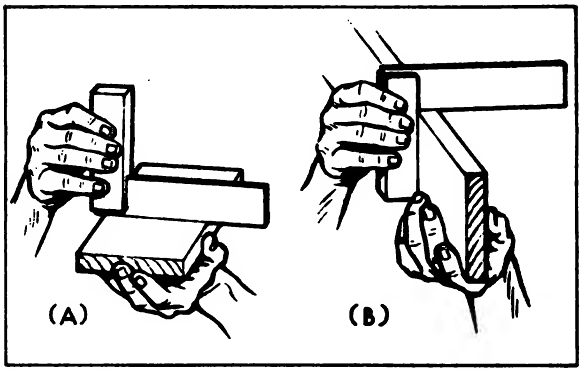


Fig.1 Testing Face and Edge with a Try Square.

SPIRIT LEVEL.

The spirit level is dependent on the fact that an air bubble enclosed with an accompanying liquid in a glass tube will always rise to the highest point. Lines marked on the tube indicate where the bubble should come to rest.

To check the level, set it up on a firm base with the bubble registering centrally; then reverse the ends of the level, when the bubble should again register a central position. Any inaccuracy should be corrected. For a long level line the spirit level is used on a straight edge, as shown in Fig. 2.

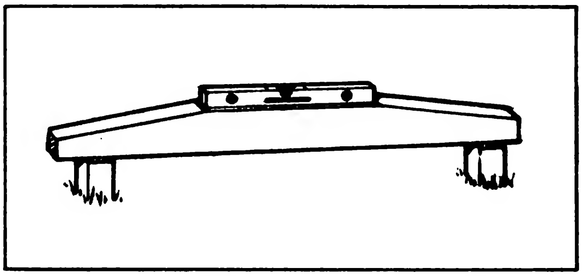


Fig.2 Testing with a Spirit Level.

PLUMB BOB AND PLUMB RULE.

The plumb bob is a tool frequently used to secure a vertical face. The plumb bob is very heavy and keeps any suspending cord taut and vertical.

Specially shaped straight edges are used with the plumb bob and a line. This tool is then called a plumb rule. Applications of the plumb bob and the plumb rule are shown in Fig. 3.

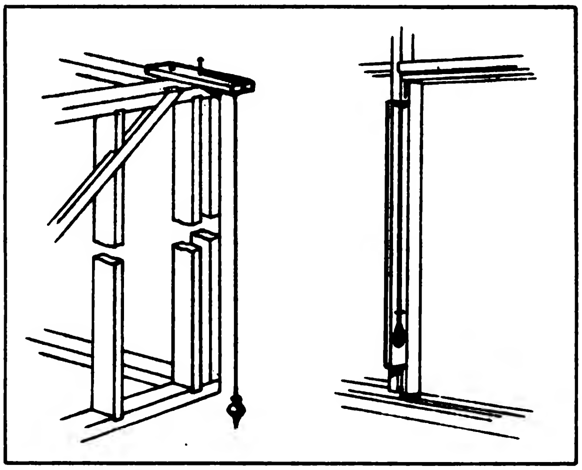


Fig.3 Testing with Plumb Bob and Plumb Rule.

LINE LEVEL.

The line level is a short and very light level which has hooks at each end so that it may be hung on a line. It is used to test the approximate levelness of a stretched line for excavation lines and lines of height. The line level is shown in Fig. 4.

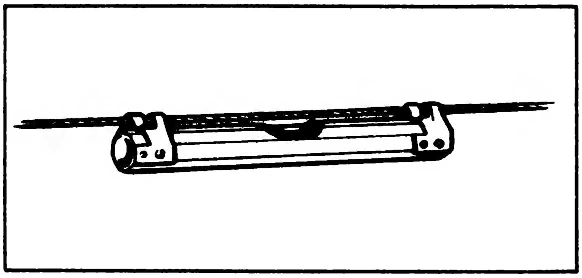


Fig.4 A Line Level.

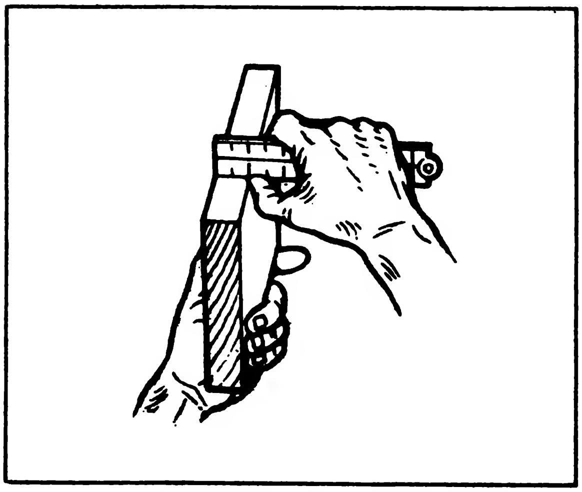


Fig.1 Measuring with a Folding Rule.

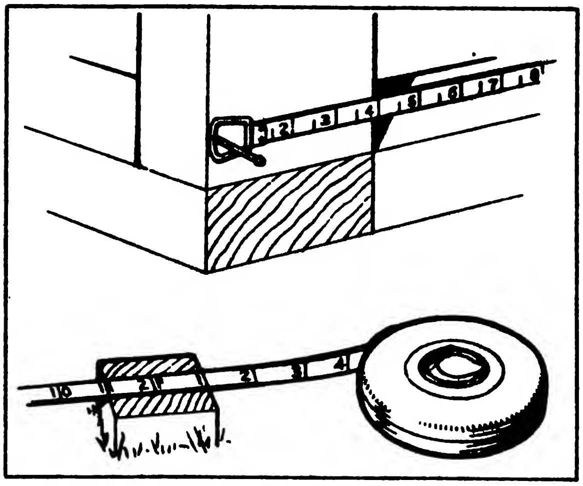


Fig.2 Two Applications of the Steel Tape.

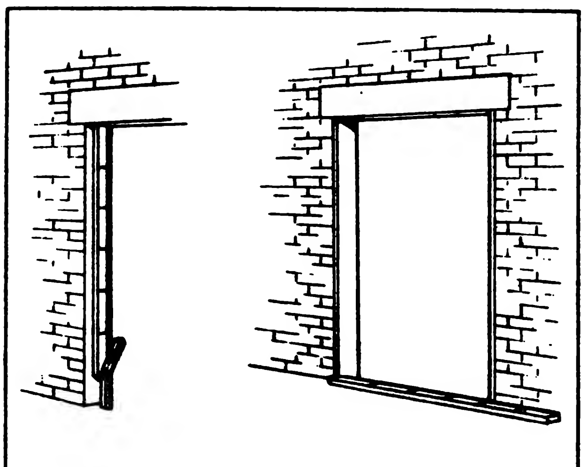


Fig.3 Applications of Measuring Rods.

FOLDING BOXWOOD RULE.

The folding rule is used for taking short measurements, as shown in Fig. 1. It can be extended or folded up quickly and is designed to be carried in the rule pocket of the carpenter's overalls. It is made in 2 and 3 ft. lengths, both of which have four folds. Rules are graduated in sixteenths of an inch and figured in inches.

The commonest type is the 3 ft. rule, which is particularly useful on building work where so many timber members are spaced out at 3' and 18" centres.

STEEL TAPE.

The steel tape is a flexible ribbon of steel, made in 33' and 66' lengths, and graduated in feet, inches, and eighths of an inch. The unit length of 66' is taken because it is a common measurement for a surveyor to use, being the length of a chain, which is a factor of a mile.

Tapes are also obtainable in woven cotton but the legibility of their graduations does not remain on them as long as those on a steel tape. Great care must be taken to see that steel tapes are not moist when rolled up and are not twisted during use. Two applications of the steel tape are shown in Fig. 2.

MEASURING RODS.

Measuring rods are made on a building site or transported from one site to another. The rods are in varying lengths of from 6 to 20 ft. and are graduated in feet and half feet. For smaller graduations a folding rule is used in conjunction. On account of their rigidity they can be used for heights where tapes would not be applicable. Applications of the use of measuring rods are illustrated in Fig. 3.

COMMON FEATURES.

Saws may be conveniently divided under three headings, hand saws, back saws, and those for cutting curves. There are, however, several features common to all.

Length is always taken from the actual blade, regardless of the handle. Tooth size is reckoned as so many points to the inch, including those at both ends. Fig. 1 shows the teeth of a rip saw and a cross cut saw. It will be seen that the teeth are cut at an angle to the general line of the saw, and that this varies according to the particular type of saw. The lower the angle at which they are inclined the smoother the finish and slower the cut.

All teeth too, have what is known as "set", that is, they are bent over alternately one way and then the other. Thus they cut a kerf which gives easy clearance to the blade. This set should be kept to a minimum, otherwise the tool removes a great deal of sawdust unnecessarily. In all good hand saws this detail is helped by the blade being taper ground, being thinner at the back than at the tooth edge. This gives a clearance in itself and makes excessive set unnecessary, except in cutting wet material.

RIP SAW.

The rip saw is used for cutting along the grain. It may be 26 to 28 inches long with a tooth size of 3 to $5\frac{1}{2}$ points to the inch. One feature in which the rip saw differs from all other saws is that the teeth are sharpened straight across at right angles to the blade so that the points present a series of chisel-like edges to the wood, as shown in Fig. 2A.

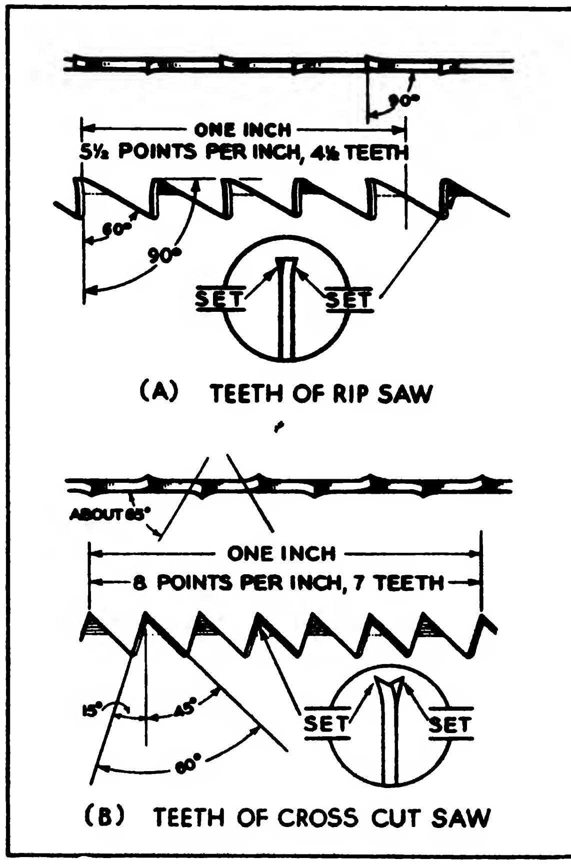


Fig.1 Teeth of Rip Saw and Cross Cut Saw.

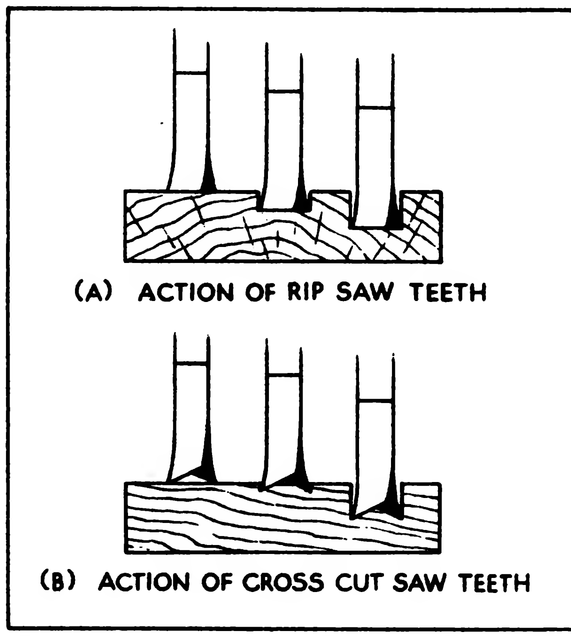


Fig.2 Cutting Action of Rip and Cross Cut Saws.

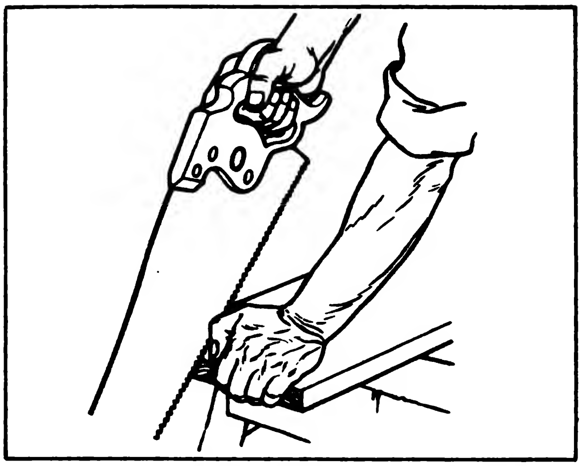


Fig.3 Commencing the Cut with a Rip Saw.

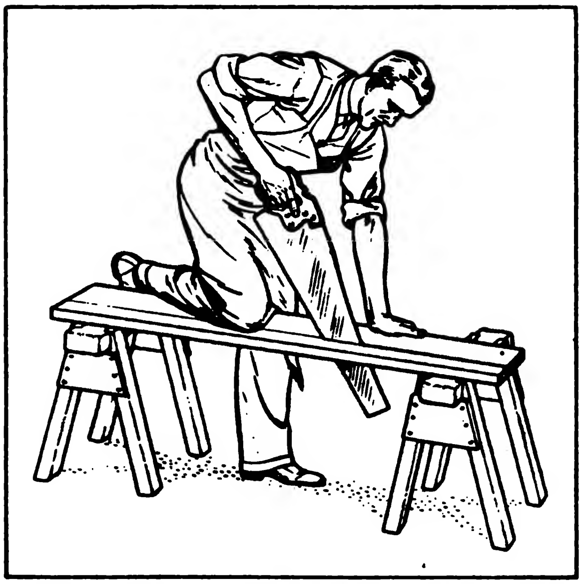


Fig.4 Fig.4 Ripping a Board on Saw Stools.

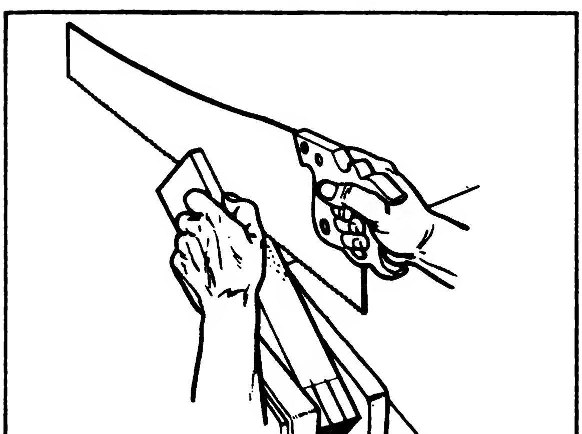


Fig.5 Ripping Timber held in the Vice.

The cut is started with a few short strokes, with the thumb of the left hand leaning against the blade to steady it, as shown in Fig.3. When a start has been made the saw should be worked with full strokes, the blade being held so that the line of the teeth. is at about 60° with the wood, as shown in Fig.4. Note that the index finger of the right hand points along the blade. This ensures better control over the saw.

Apply more pressure on the downward stroke after the saw is started. Always rip on the waste side of the line, as shown in Fig.5, as cutting on the line or against the wrong side of the line will give an incorrect size of finish. Keep the saw in alignment by sighting along it. If the saw tends to bind in the cut use a wedge to spread out the saw cut. A little wax or oil on the saw blade helps to eliminate friction.

When ripping a large board, place it on a saw horse. Finish ripping the board with short easy strokes and hold the waste side of the board with the left hand to steady it and to prevent splitting.

When ripping small size timber, clamp it in the bench vice. Adjust the height of the timber frequently so that the cutting edge of the saw is always near the top of the vice. If the saw cut is made too far above the vice the timber is liable to chatter, and inaccurate cutting will result. Clamp the timber in the vice as often as possible at an angle of approximately 60°, and keep the saw running level.

When it is necessary to hold a wide board in the vice and cut across the bench line, keep the heel of the saw lower than the toe to give smooth cutting.

CROSS CUT SAW.

The cross cut saw is used for cutting across the grain, as shown in Fig.6. It might be used for ripping, though it is slower cutting for this purpose. The operation of cross cutting is similar to that of ripping on the saw stools. When the cut is nearly finished, the left hand should be brought over the blade to support the wood, otherwise the weight of the projecting piece may cause it to splinter as it drops off.

BACK SAWS.

The stiffening strip of brass or iron gives these saws their name. Their chief use is in cutting joints and in bench work generally. A 12 or 14 inch tenon saw, with 12 to 14 points per inch; and a dovetail saw of 8 to 10 inches, with 18 to 20 points to the inch are useful. A bench hook should be used to stop the timber from moving during sawing. The method of using a back saw to start the cut in a housing joint is shown in Fig. 7.

SAWS FOR CUTTING CURVES.

The compass or keyhole saw is used to cut curved and straight holes, as shown in Fig.8. It is also used for cutting curved outside edges.

The coping saw is used for cutting intricate shaped holes or outside curves in thin timber. The narrow fine toothed blade is held in a spring steel frame, to give it proper tension. The blade may be turned at various angles in relation to the frame.

One method of using the saw for this work is shown in Fig.9. The coping saw is greatly used for sawing the moulded shapes on the ends of scribed or returned mouldings and for removal of waste in dovetails.

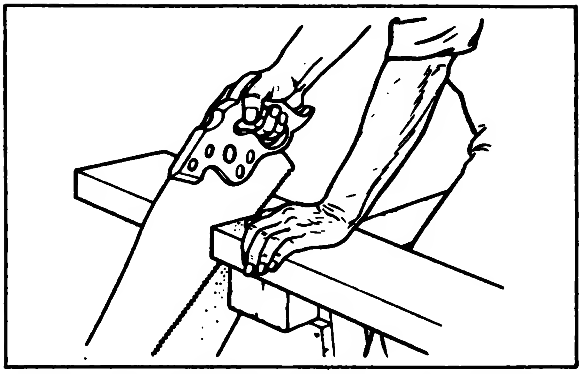


Fig.6 Cross Cutting Scantling on Saw Stools.

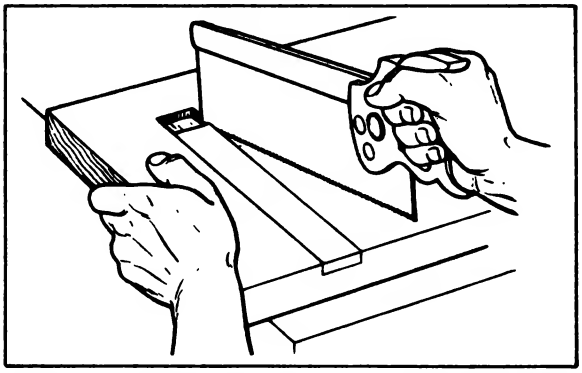


Fig.7 Cutting a Housing Joint with a Back Saw.

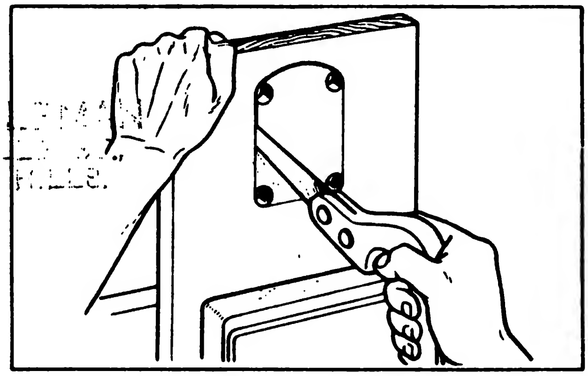


Fig.8 Cutting a Hole with a Key Hole Saw.

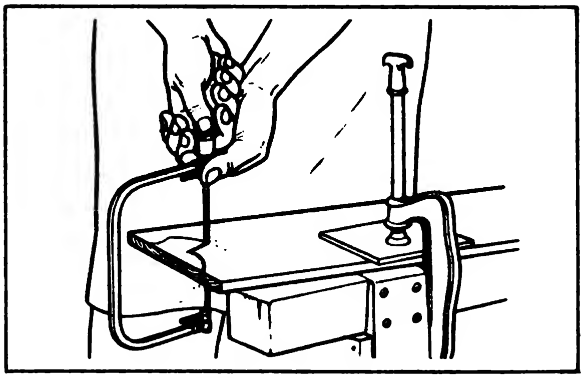


Fig.9 Using the Coping Saw.

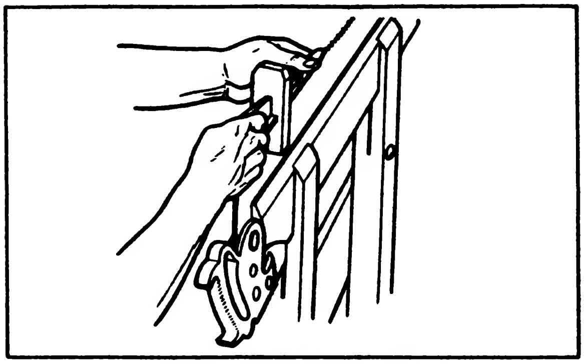


Fig.1 Breasting a Saw.

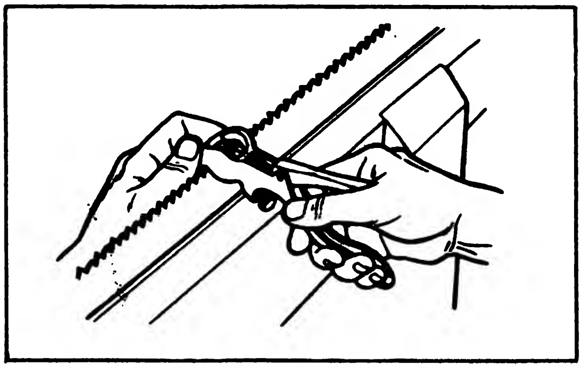


Fig.2 Setting a Saw with a Saw Set.

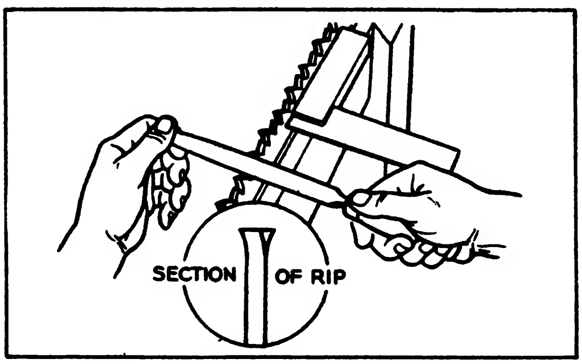


Fig.3 Filing the Teeth of a Rip Saw.

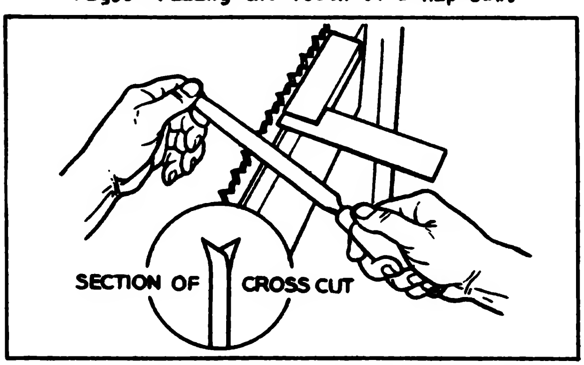


Fig.4 Filing the Teeth of a Cross Cut Saw.

The setting and sharpening of a hand saw consists of four operations, breasting, shaping the teeth, setting, and filing. A saw needs breasting only when the teeth are incorrectly shaped or are uneven. The method of performing this operation is shown in Fig. 1. Keeping the file level, run it lightly over the tops of the teeth until it cuts off the tops of high teeth and finishes off all the teeth to a slightly curved line.

After a saw is breasted the gullets will be of unequal depth and the teeth will be of uneven size. File the gullets to equal depth, shaping the front and back of each tooth. Place the file well down in the gullet and file straight across the saw, keeping the file at right angles to the saw blade.

Setting a saw consists of springing over the upper part of each tooth, springing one to the left and the next to the right to make them cut a kerf slightly wider than the thickness of the blade in order to give blade clearance. This is done with an adjustable saw set, as shown in Fig. 2.

When filing a rip saw the file is held in a horizontal position at right angles to the blade, as shown in Fig. 3. File each alternate tooth from one side, reverse the saw, and file the remaining teeth from the opposite side.

The teeth of a cross cut saw are bevelled and to file this saw the file must therefore be held at an angle to produce this bevel, as shown in Fig. 4. An angle of 55° to 60° has been found to be most satisfactory for general use. The teeth must be filed alternately from opposite sides.

Chisel blades are made of steel in several shaped sections and are fitted with wooden handles, to suit the work they are designed to do. The size is determined by the width of the blade. The narrowest are $\frac{1}{16}$". They rise in sixteenths up to $\frac{1}{2}$" and then in eighths up to $1\frac{1}{2}$".

The socket chisel is designed for heavier types of work where it is necessary to use a mallet and force it into the wood, such as for mortising, as shown in Fig.1. A conical shaped socket is provided on the handle end of the chisel into which the handle fits.

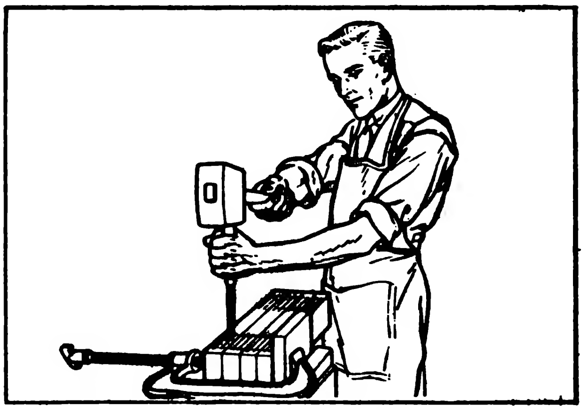


Fig.1 Method of Using Mortise Chisel.

Lighter chisels having shouldered tangs to fit into holes in the wooden handles, and known as firmer chisels, are used for lighter cutting along the grain, as shown in Fig.2, or for cutting the waste between saw cuts, as shown in Fig.3. Firmer chisels have only one hoop around the handle at the blade end. Registered chisels have iron hoops on both ends of the handle, to prevent them from splitting, and so can be used for heavier work.

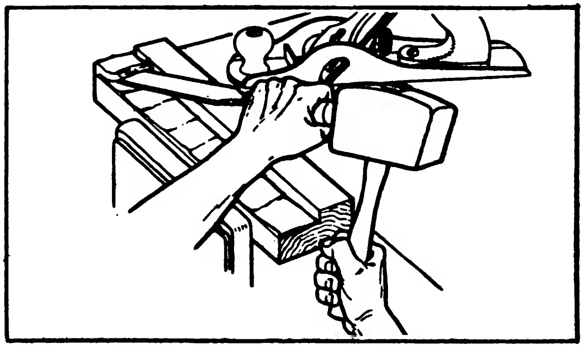


Fig.2 Firmer Chisel used for Cutting with Grain.

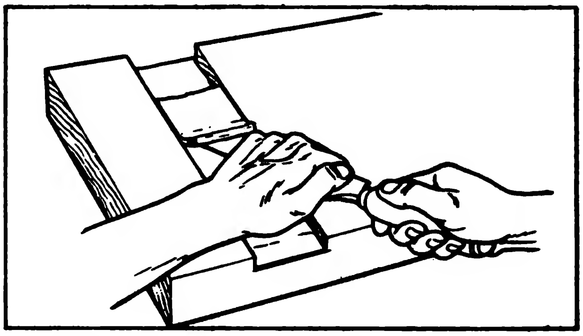


Fig.3 Firmer Chisel used for Trenching.

Chisels that have bevelled edges are made of harder tempered steel than those with rectangular blades and will sharpen up to a very fine edge. They have distinctive octagonal boxwood handles and are classed as paring chisels.

When paring, the left hand guides the chisel while force is applied by the right hand, as shown in Fig.4. Take care that the left hand is always behind the cutting edge of the chisel. In vertical paring, the left hand guides the chisel while weight is applied from the shoulder.

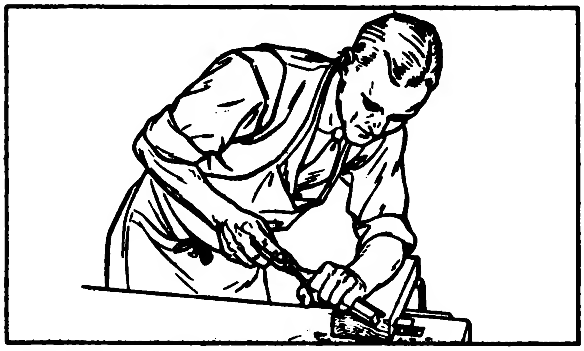


Fig.4 Paring Chisel used for Horizontal Paring.

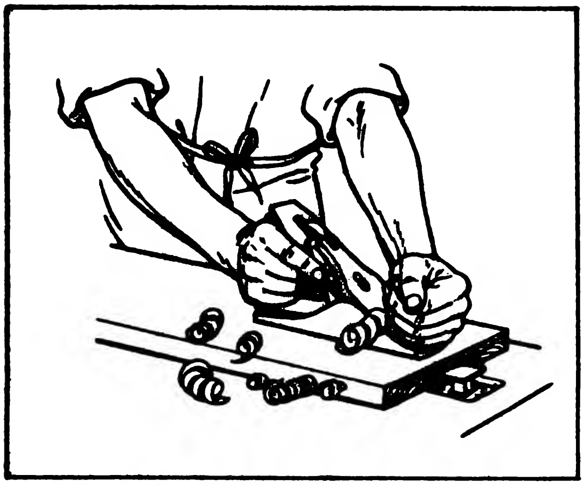


Fig.1 Method of Holding Smoothing Plane.

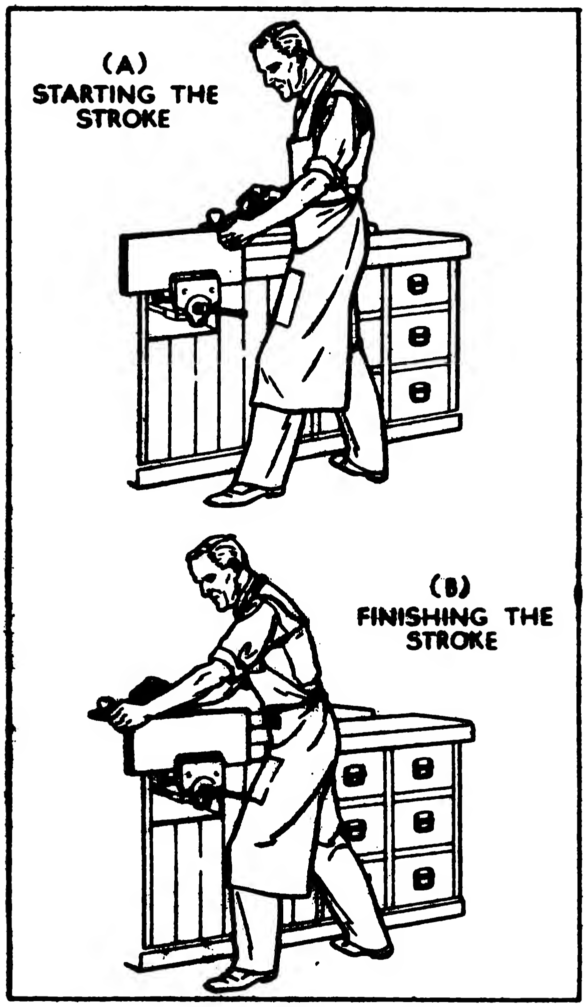


Fig.2 Stance when Planing.

The planes in common use are the jack plane, smoothing plane and jointer plane. All are similar in construction but vary in size.

The jack plane leaves only a medium quality finish and really prepares timber for cleaning by a smoothing plane. Smoothing planes are smaller and are used for smoothing level surfaces and for fine work. Iron smoothing planes are most useful for cleaning faces and edges of timber, as well as the end grain.

A properly adjusted plane should take off a long thin tissue-like shaving. In the case of a wooden plane, careful setting is required. In an iron plane, a brass thumb screw located in front of the handle controls the cutting depth.

The method of holding the plane is shown in Fig. 1. More care is needed to keep the plane level when planing edges or ends of stocks than for a flat surface, as a narrow surface does not give as much support to the sole of the plane.

When possible, plane with the grain. To do this with timber of irregular grain, it may be necessary to plane in one direction at one end of the board and in the opposite direction at the other end.

In starting the stroke, place the pressure on the knob. When the toe and the heel of the plane are in contact with the stock, apply pressure equally on the knob and the handle. At the end of the stroke, apply pressure to the handle.

An easy and firm stance, directly behind the work, is adopted, as shown in Fig. 2A. At the end of the stroke, the weight of the body should be carried easily on to the left foot, as shown in Fig. 2B.

To grind a uniform bevel on a plane iron, move it across the wheel the full width of the iron, as shown in Fig. 1A, using water to keep the edge cool. The grinding angle is about 25 to 30 degrees.

Whetting the plane iron is the process of putting a keen edge on it by honing. This is done by rubbing the iron over the surface of an oil-stone, as shown in Fig. 1B. The whetting angle is 30 to 35 degrees. Use as much of the surface of the stone as possible, in order to keep the stone flat. Apply a moderate amount of pressure as the plane iron comes to a keen edge.

Remove the wire edge which has formed on the unbevelled side by holding the plane iron with the unbevelled side absolutely flat on the stone. Move back and forth, using care not to raise the plane iron while in motion, otherwise a bevel will be produced on the flat side. This will allow shavings to collect between the plane iron and the back iron and thus clog the plane. Remove the wire edge during the whetting as often as is desired.

To set the plane, adjust the back iron with the left hand and tighten the screw with the fingers and then with a screw driver, as shown in Fig. 2. The distance the back iron is set back from the cutting edge depends on the thickness of shaving required. For fine work set it close to the cutting edge, and for coarse work set it back about $\frac{1}{3}$ of an inch.

Insert the plane iron in the plane so that it just projects from the sole and hold it with the thumb as shown in Fig. 3A; then tighten the wedge with the finger, then with a hammer, as shown in Fig. 3B.

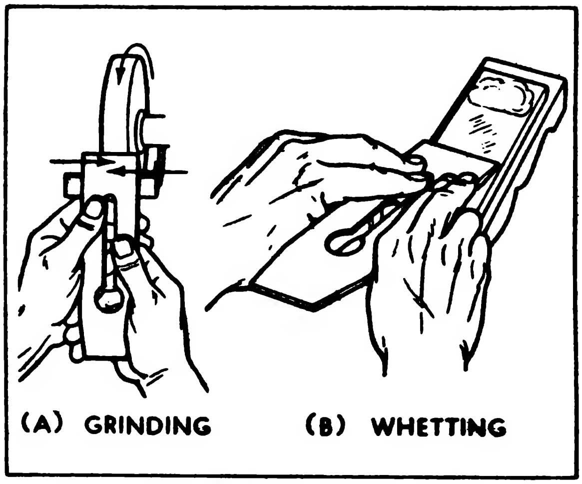


Fig. 1 Grinding and Whetting Plane Iron.

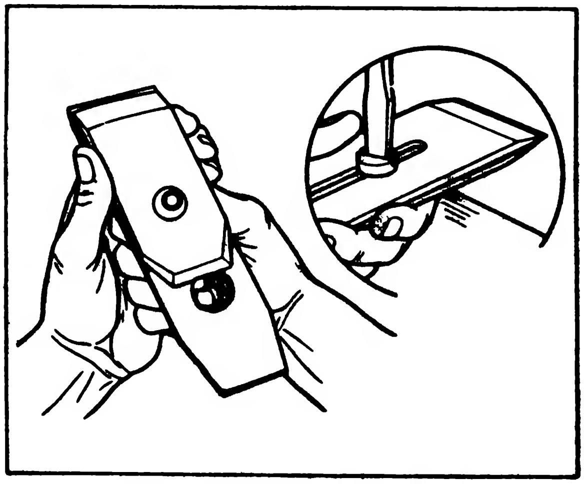


Fig. 2 Adjusting the Back Iron.

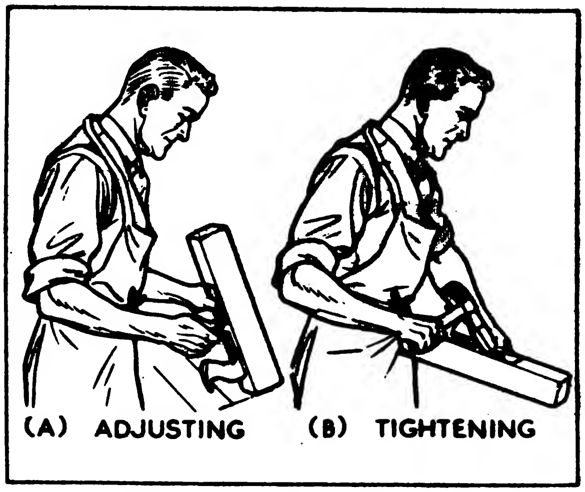
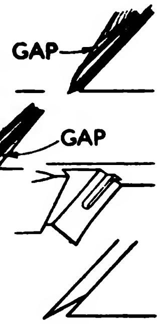
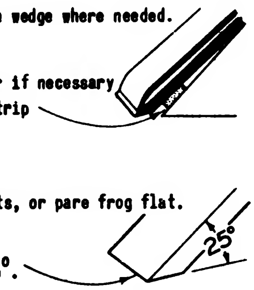
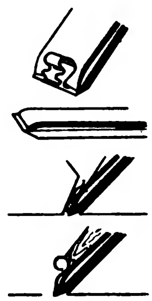
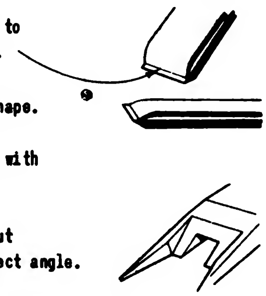
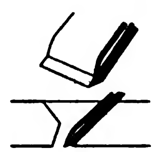
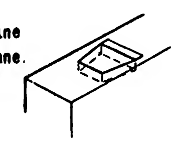
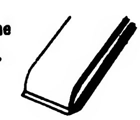
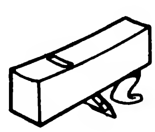
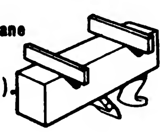
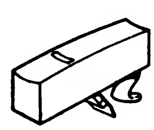
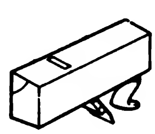
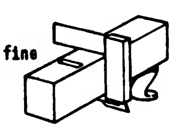


Fig. 3 Inserting the Plane Iron.

FAULTS IN YOUR PLANE

FAULT	CAUSE	REMEDY
CHATTERING	Wedge does not fit properly (especially on a new iron). Cutter does not seat on frog. Frog has twist. Cutting angle too acute. 	Take shaving from wedge where needed. Straighten cutter if necessary or fit leather strip near opening. Refit wedge points, or pare frog flat. Grinding angle 25°. 
CHOKING	Back iron does not seat properly. Back iron wrong shape. Insufficient clearance in escapement. Wedge points broken or not properly tapered. 	Whet underside to seat perfectly. Whet to this shape. Enlarge throat with chisel. Refit wedge, cut points to correct angle. 
TEARS OUT GRAIN	Back iron not close enough to cutting edge. Mouth too large. 	Not more than 1/32" for fine shaving with smoothing plane. Fit a new mouth. 
WORKS STIFFLY	Back iron too close to cutting edge. Sole needs lubricating. 	About 1/32" for smoothing plane and 1/8" or more for jack plane. Linseed oil on felt pad. 
DOES NOT WORK TRUE	Sole is hollow. Sole is round. 	True up sole with trying plane (slightly withdraw cutter, keep irons and wedge tight). Test with winding sticks. 
REMOVES ONLY THICK SHAVINGS	Sole out of true. Worn mouth. 	True up sole with irons and wedge in position (set cutting edge back in mouth).
WORK BEVELLED ON SHOOTING BOARD	Sole not square with sides. 	Test with square and take fine shaving off sole or side. 

BRACE AND BITS.

The brace is the tool which holds and guides bits for boring holes. The ratchet brace permits the boring of a hole where the handle of the brace cannot make a full sweep or revolution. The method of holding the brace for vertical boring is shown in Fig. 1, and for horizontal boring, in Fig. 2.

Four commonly used wood bits are illustrated in Fig. 3. Auger bits are used in sixteenths of an inch, starting from 3/16 inch. The leading screw centre of the auger bit pulls the bit into the wood.

To prevent splintering, when boring through a board, do not bore all the way through from one side. Bore until the feed screw goes through the board, and then bore from the other side.

Another way to prevent splintering is to clamp a piece of wood to the under side of the board to take the thrust of the bit. The expansive bit has an adjustable cutter and will take the place of several large size bits.

Gimlet bits are designed to drill holes for screws and nails. They have a slim tapered point which leaves a tapered hole suitable for screws. They bore rapidly and leave a fairly smooth hole. In size they range from $\frac{1}{8}$ to $\frac{3}{8}$ inch by thirty-seconds.

After boring for a short distance, they are liable to choke and must be withdrawn, else they break. It is very difficult to remove from a piece of timber the point of a broken bit, so care must be exercised in use.

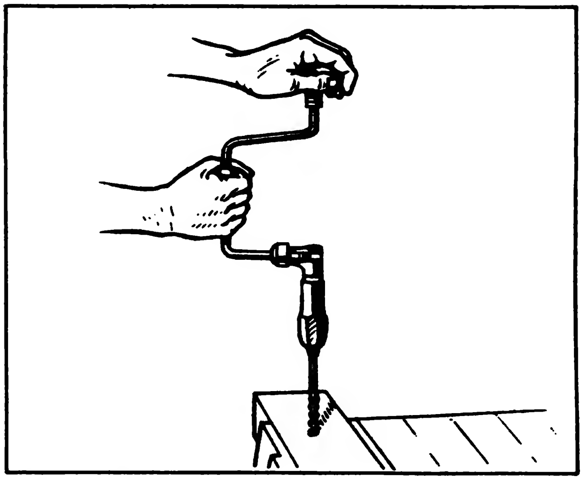


Fig.1 Vertical Boring with Brace and Bit.

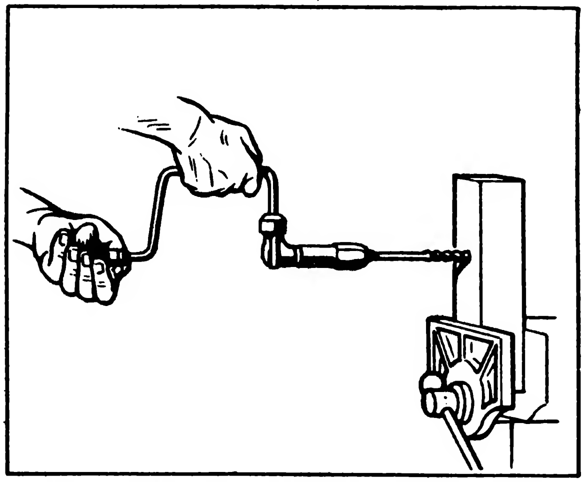


Fig.2 Horizontal Boring with Brace and Bit.

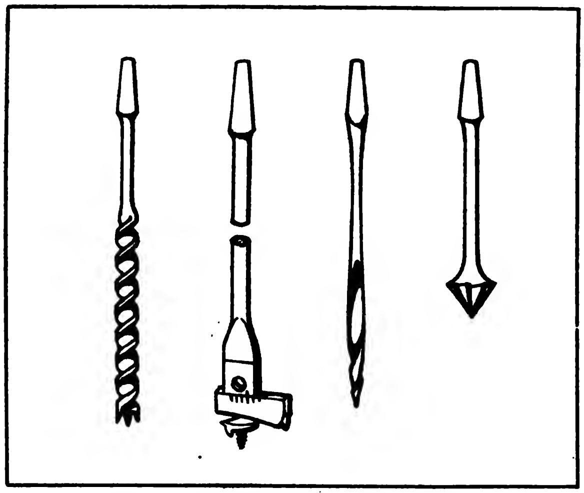


Fig.3 Four Kinds of Wood Bits.

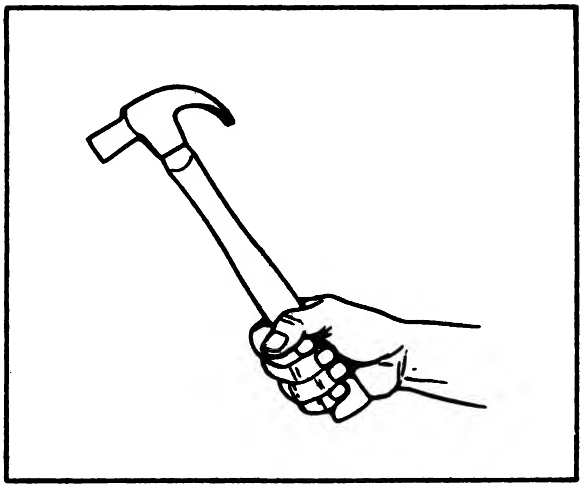


Fig.1 Method of Holding Hammer.

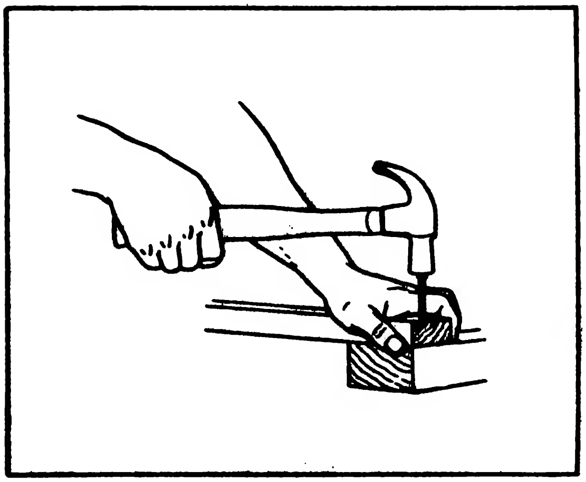


Fig.2 How to Drive a Nail.

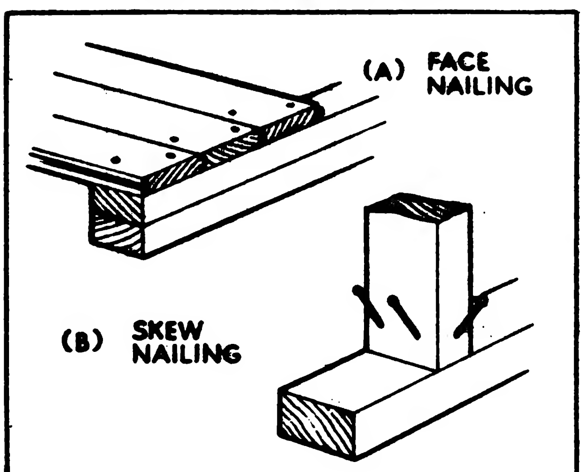


Fig.3 Two Methods of Nailing.

Practically all of the materials handled by the carpenter must be assembled or fastened in place by either face nailing, skew nailing, or edge nailing, with the aid of a hammer.

To use a hammer, grasp it firmly at the end of the handle, as shown in Fig. 1. Hold the nail between the forefinger and thumb, pointing it in the direction in which it is to be driven, and tap the nail lightly to get it started.

To drive the nail, swing the hammer so that it will hit the nail squarely on the head. After the nail is well started, remove the hand and drive the nail home with well directed blows in alignment with the nail, as shown in Fig. 2.

Driving nails at approximately right angles to the surface of a board is called face nailing. Nails should not be driven too close to an edge or end without first boring holes as there is a danger of splitting the wood. Staggering the nails, as shown in Fig. 3A, is better than driving them along the line of the grain.

Skew nailing is done by driving the nail at an angle to the face or edge, as in the case of a stud where it meets a sill, as shown in Fig. 3B. In this type of nailing, hammer marks frequently occur when driving the nails home. However, since the nailing is used on framework members which are to be concealed, these marks will not show.

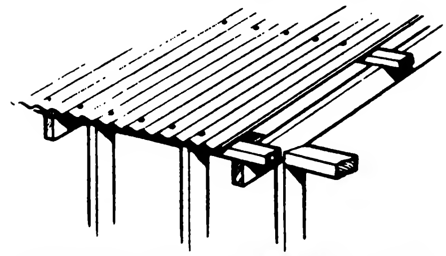
Fig. 4 shows types of nails in general use, and common sizes of wire nails, as well as methods of nailing.

NAILS

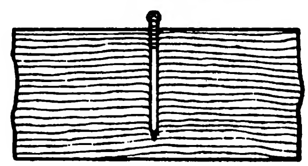
COMMON SIZES OF WIRE NAILS

In wire nails & brads, sizes of sections decrease as gauge figures rise.

LENGTH	GAUGE														
6"		4													
5"			5												
4"				6	7	8									
3½"					7	8									
3"					7	8	9	10	11	12					
2½"							9	10	11	12					
2¼"	OVAL FLOOR BRADS								11	12					
2"							9	10	11	12	13	14			
1¾"										12	13	14			
1½"										12	13	14	15	16	
1¼"											13	14	15	16	
1"												14	15	16	
¾"														16	17



SPRING HEAD NAILS IN CORRUGATED IRON



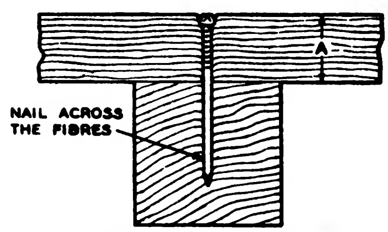
FIBRES GRIP SHAFT OF NAIL

BRADS

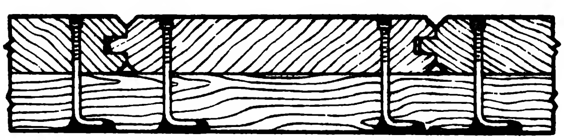
LENGTH	GAUGE				
2"	16				
1¾"	16				
1½"		17			
1¼"		17			
1"		17	18	19	
¾"		17	18	19	
⅝"			18	19	
½"				19	20

CLOUTS

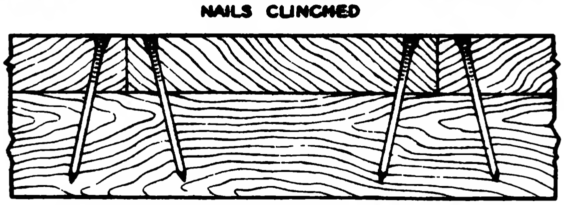
LENGTH	GAUGE			
1½"	10	11	12	
1¼"	10	11	12	
1"		11	12	13
⅞"		11	12	13
½"				13



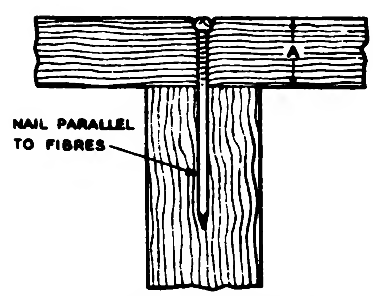
SUITABLE LENGTH NAIL = 2½ A



NAILS CLINCHED



METHOD OF NAILING TO OBTAIN BETTER GRIP



SUITABLE LENGTH NAIL = 3A

Fig.4 Types and Sizes of Nails.

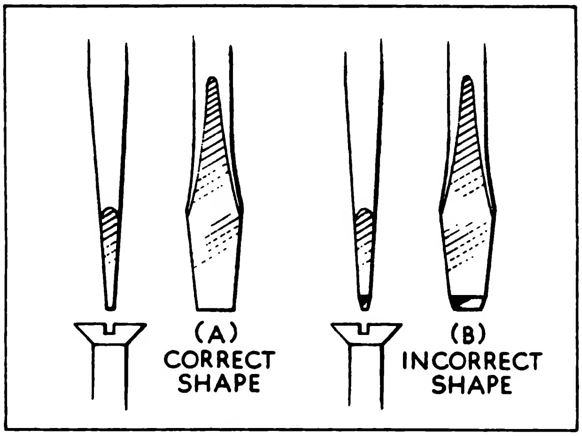


Fig.1 Correct and Incorrect Screw Driver Tips.

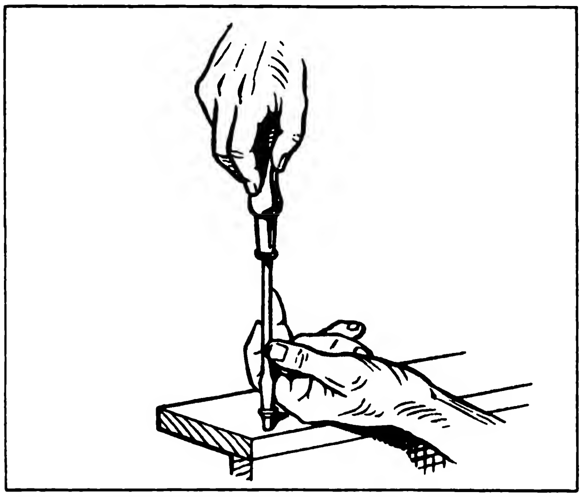


Fig.2 Driving Screws with a Hand Screw Driver.

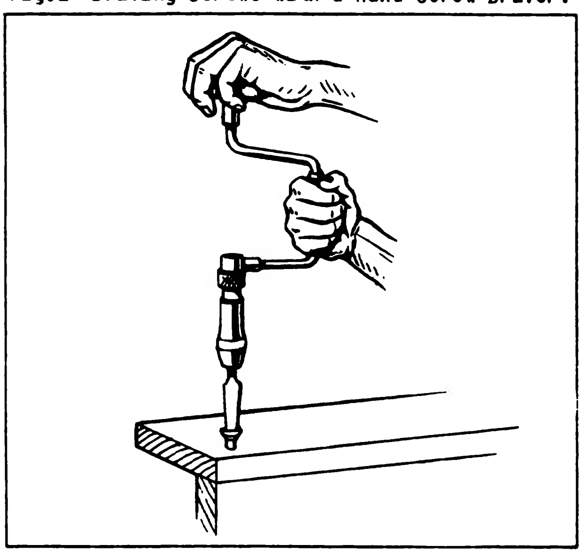


Fig.3 Driving a Screw with a Bit and Brace.

Next to nails, screws are the most common fasteners used in woodwork. Setting screws requires more time and labour but gives a stronger joint. Another advantage of the screw is the ease of taking apart and re-assembling.

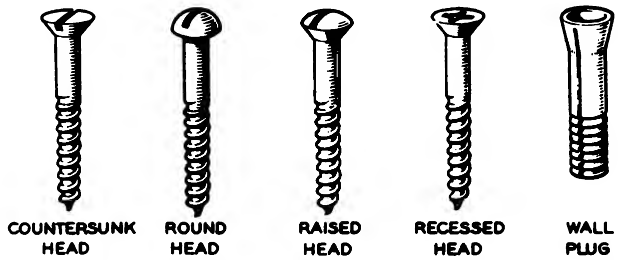
Screws may be driven either by a hand screw driver, a ratchet or spiral ratchet screw driver, or a screw driver bit in a brace. Always use the longest screw driver convenient for the work. More power can be applied with a long screw driver than with a short one, and there is less danger of it slipping from the slot of the screw. The width of the bit should equal the length of the slot, as shown in Fig. 1A. An improperly sharpened bit, as shown in Fig. 1B, will jump out of the slot and damage the head of the screw or mar the surface of the wood.

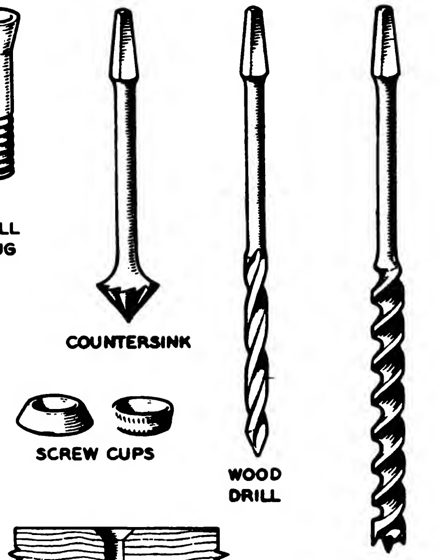
To use a hand screw driver, hold the handle firmly in the palm of the right hand with the thumb and forefinger pointing along the handle. The left hand should steady the tip and keep it pressed into the slot while renewing a grip on the handle for the next turn, as shown in Fig. 2. The method of driving a screw with a screw driver bit and brace is illustrated in Fig. 3.

Types of wood screws in general use and sizes of screws are shown in Fig. 4. Before a screw is inserted, holes should be bored with an auger bit, wood drill or gimlet, to receive the screw.

Special metal plugs are manufactured which expand as screws are driven into them. They must be inserted in brickwork or concrete in holes of diameter closely approximate to that of the plug.

SCREWS, NUTS AND BOLTS

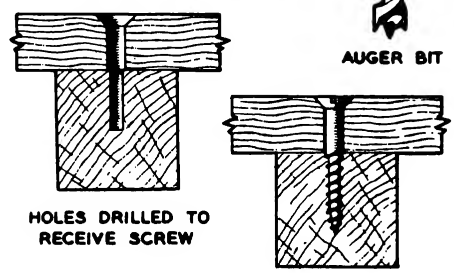




SIZES OF SCREWS

NOTE:– Diameters increase as gauge numbers rise.

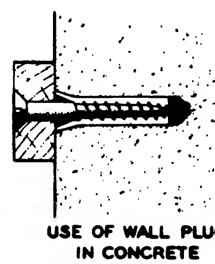
LENGTH	NUMBER OF GAUGE																
¼"	1	2	3	4													
⅜"	1	2	3	4													
½"	1	2	3	4	5	6	7	8									
⅝"	1	2	3	4	5	6	7	8									
¾"		2	3	4	5	6	7	8	9	10	11	12					
⅞"			3	4	5	6	7	8	9	10	11	12	14				
1"				4	5	6	7	8	9	10	11	12	14				
1¼"						6	7	8	9	10	11	12	14				
1½"						6	7	8	9	10	11	12	14				
1¾"								8	10	12	14	16	18				
2"								8	10	12	14	16	18				
2¼"									10	12	14	16	18				
2½"									10	12	14	16	18				
3"									10	12	14	16	18				
3½"										12	14	16	18				
4"											14	16	18	20	22	24	
5"												16	18	24	28		
6"														20	24	28	32

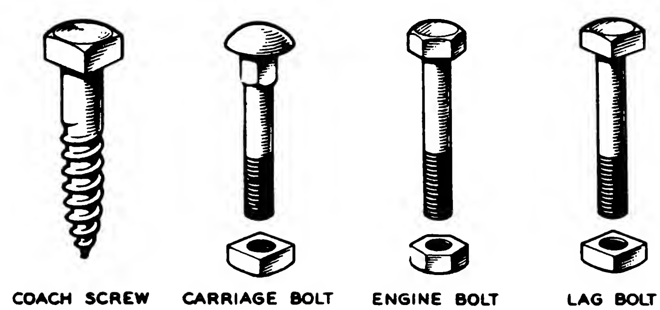


SIZES OF CUP HEAD SCREWS AND BOLTS

DIA.	LENGTH																						
$\frac{3}{16}$ & ¼"	1"	1¼	1½	1¾	2"	2¼	2½	2¾	3"	3¼	3½	3¾	4"	4½	5	5½	6						
$\frac{5}{16}$"	1"	1¼	1½	1¾	2	2¼	2½	2¾	3"	3¼	3½	3¾	4"	4½	5"	5½	6"						
⅜"	1"	1¼	1½	1¾	2"	2¼	2½	2¾	3"	3¼	3½	3¾	4"	4½	5"	5½	6"	7"	8"	9"	10"	11"	12"
$\frac{7}{16}$"	1"	1¼	1½	1¾	2"	2¼	2½	2¾	3"	3¼	3½	3¾	4"	4½	5"	5½	6"	7"	8"	9"	10"	11"	12"
½"	1"	1¼	1½	1¾	2"	2¼	2½	2¾	3	3¼	3½	3¾	4"	4½	5"	5½	6"	7"	8"	9"	10	11"	12"
⅝"			1½	1¾	2"	2¼	2½	2¾	3"	3¼	3½	3¾	4"	4½	5"	5½	6"	7"	8"	9"	10"	11"	12"
¾"															5"	5½	6"	7"	8"	9"	10"	11"	12"

Sizes from 12" to 24" long may also be obtained.
Larger sizes must be specially made.





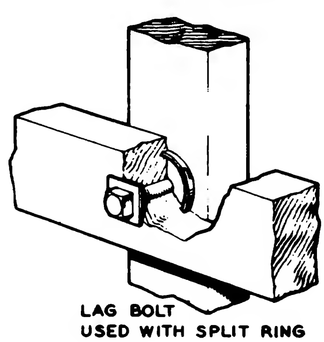


Fig.4 Types of Wood Screws, Nuts and Bolts.

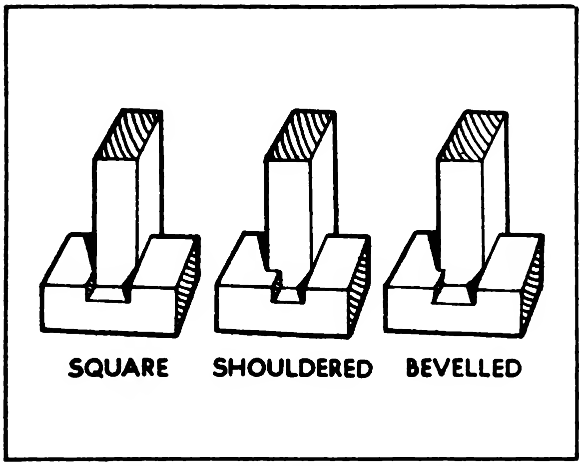


Fig.1 Types of Housing Joints.

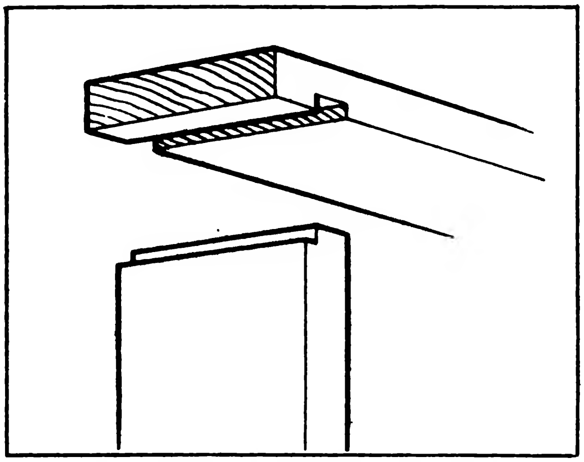


Fig.2 Housing Joint in Door Jamb Lining.

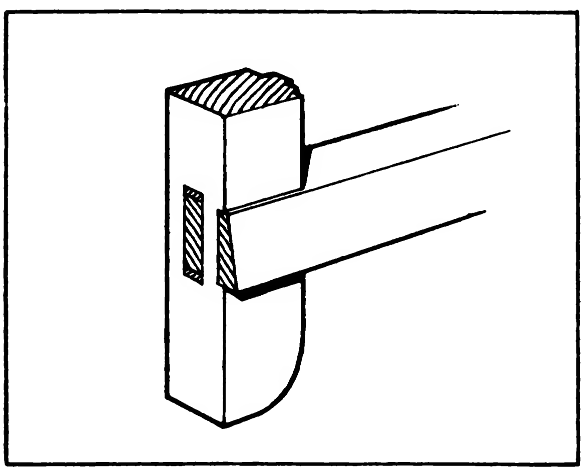


Fig.3 Meeting Rail of Top Sash.

HOUSING JOINTS.

The most frequently used joint is the housing joint which consists of two pieces of timber, one of them cut with a recess and the second piece cut either square, shouldered, or bevelled to suit, as shown in Fig. 1.

An application of the shouldered housing is the joint between the head and stile of the door jamb lining, as shown in Fig. 2. Sometimes a member is housed to hide a joint from view, or to assist in giving a joint more stability, as in the meeting rail of a top sash, as shown in Fig. 3.

The method of construction of a simple housing joint, and applications of housing joints to wall framing and to shelving, are shown in Fig. 4.

The advantage of using a stopped housing when constructing fittings, such as bookshelves and kitchen cabinets, is that the front edges of a vertical member always show an unbroken line and the shoulder of the level member is set out and cut to a length given by the thickness of the material, which can be definitely measured before cutting the joint. The overall length of the finished joint does not depend on the depth of the recess.

In constructional work housing joints are fastened with nails, coach screws or bolts. When used in exposed work the parts are treated with red lead and oil paint to prevent them retaining moisture that would cause decay. On interior work the parts are treated with glue to gain security.

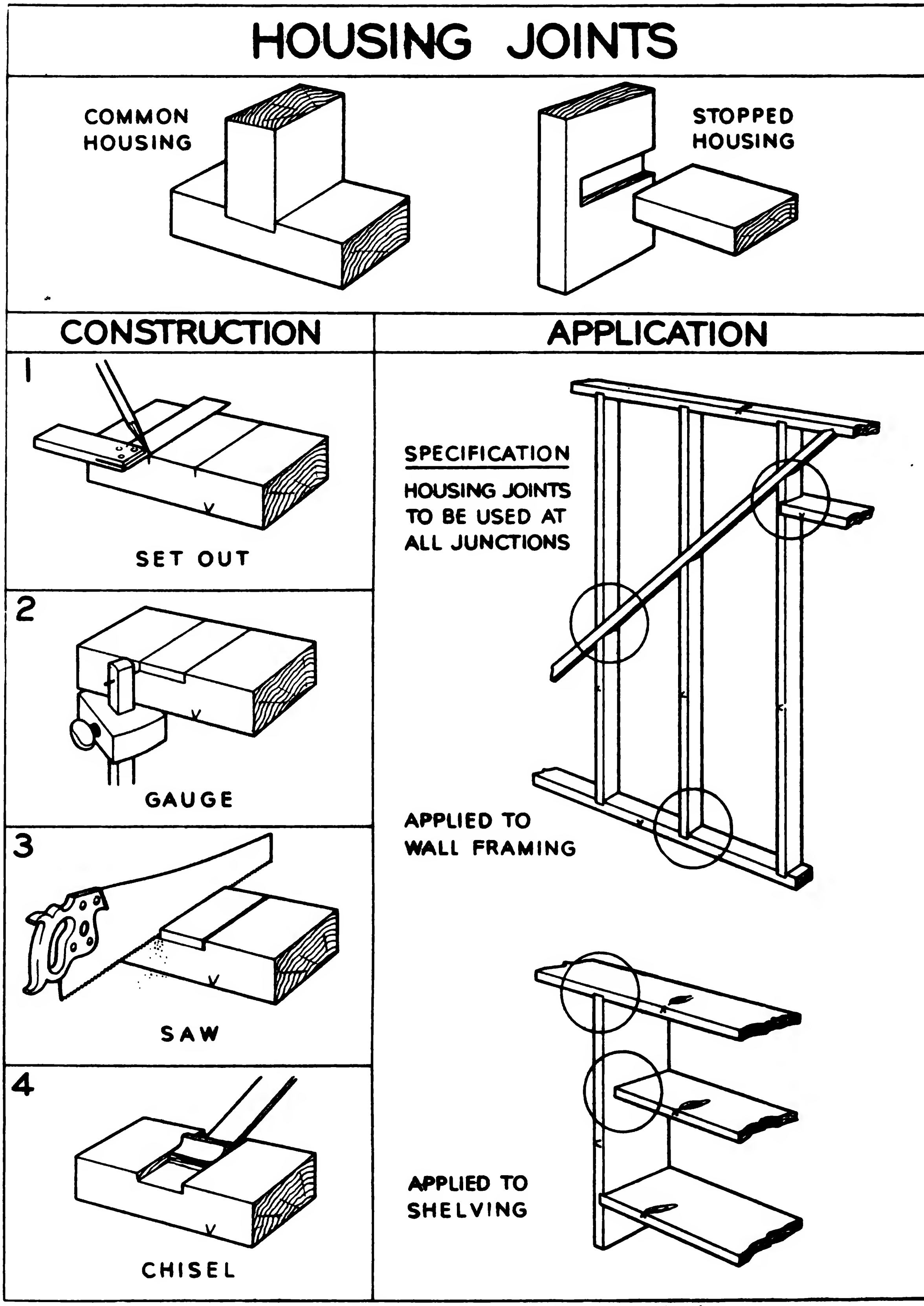


Fig.4 Construction and Application of Housing Joints.

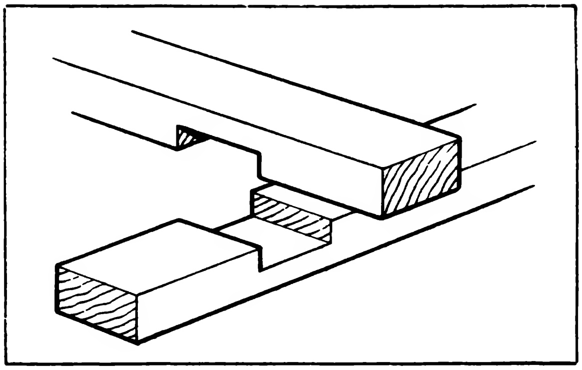


Fig.1 Cross Halving Joint.

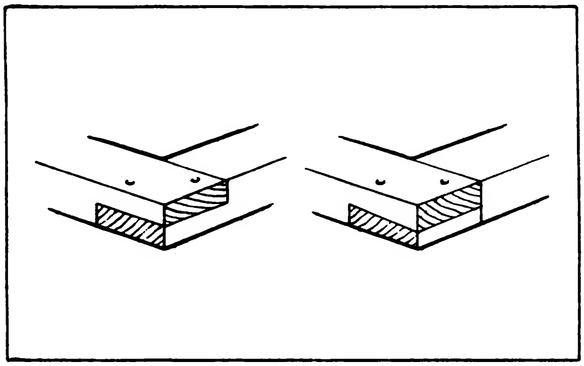


Fig.2 Halved Corner Joints.

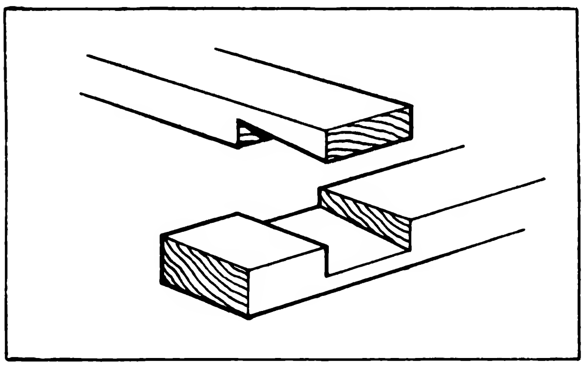


Fig.3 Bevelled Halved Joint.

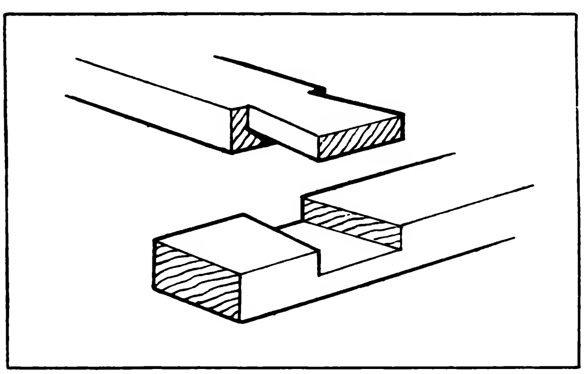


Fig.4 Dovetailed Halved Joint.

HALVING JOINTS.

A halved joint is a junction between two timbers which are similarly cut so that when fitted together the surfaces are flush. There are many different varieties of halving joints.

The use of a halving joint where two timbers cross at right angles is shown in Fig.1, a plain halved corner and a bevelled halved corner are shown in Fig.2, a bevelled halved junction is shown in Fig.3, and a dovetailed halved junction is shown in Fig.4.

The method of construction of halving joints and their application in building is illustrated in Fig.5. When setting out a halving joint mark the shoulder line and waste first, then gauge the thickness from the face of each piece. The thickness of the pieces is measured and the marking gauge is set to half the distance.

Each member is then gauged from the face around the sides and end. The lower half of the upper member and the upper half of the lower member are then cut away.

Even if the marking gauge is not set correctly the pieces will be flush when the joint is completed because the combined thickness of the two cuts equals the thickness of the member of the joint.

When extending a bearer of 4" x 3" section that stands on edge, the halving is cut 3" long. All the halvings are made at points that are directly over the foundation blocks and the 3" lap allows the full 4" depth of the two bearers to rest on the 4" block, giving the maximum strength to support the weight which will be placed on them.

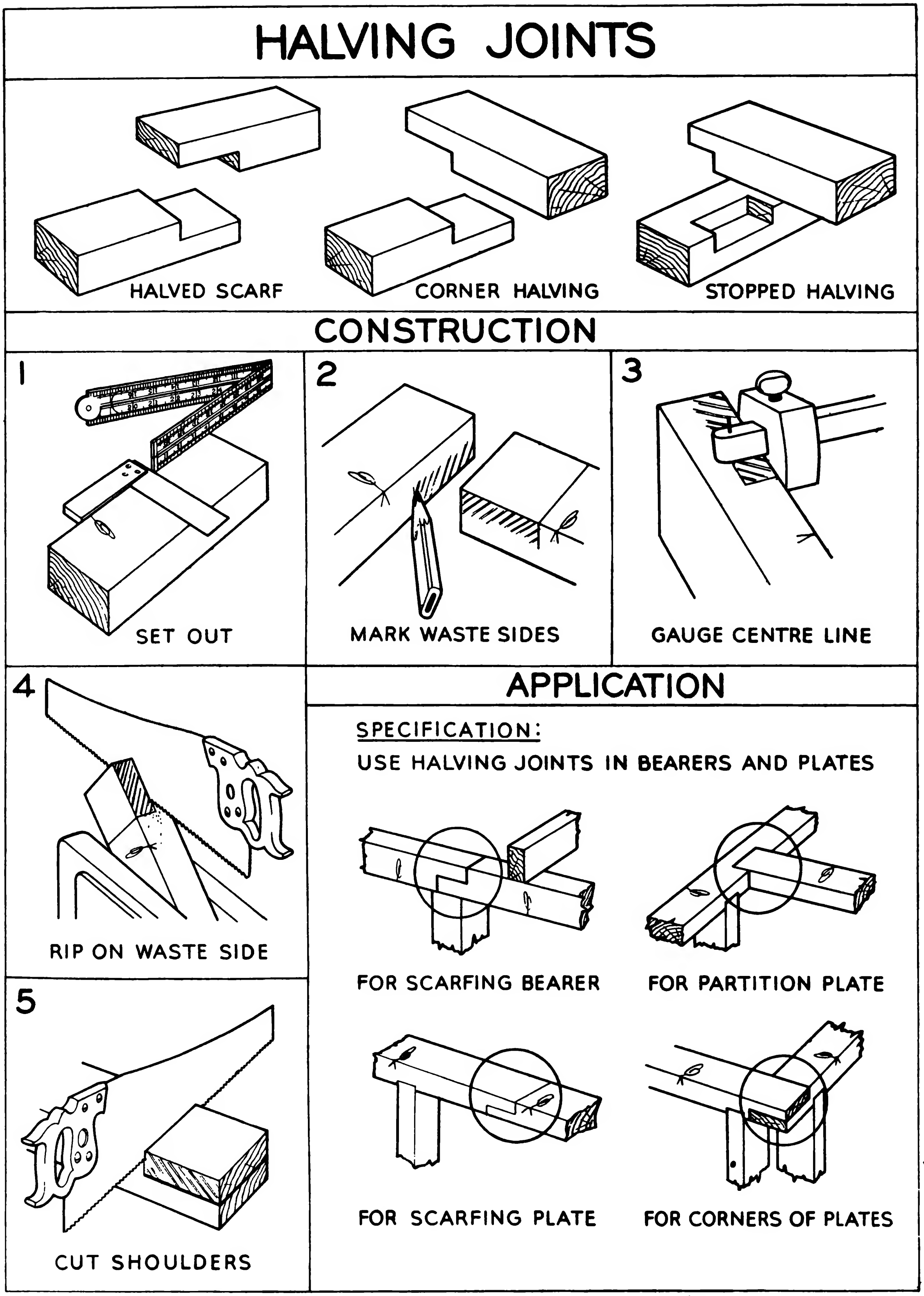


Fig.5 Construction and Application of Halving Joints.

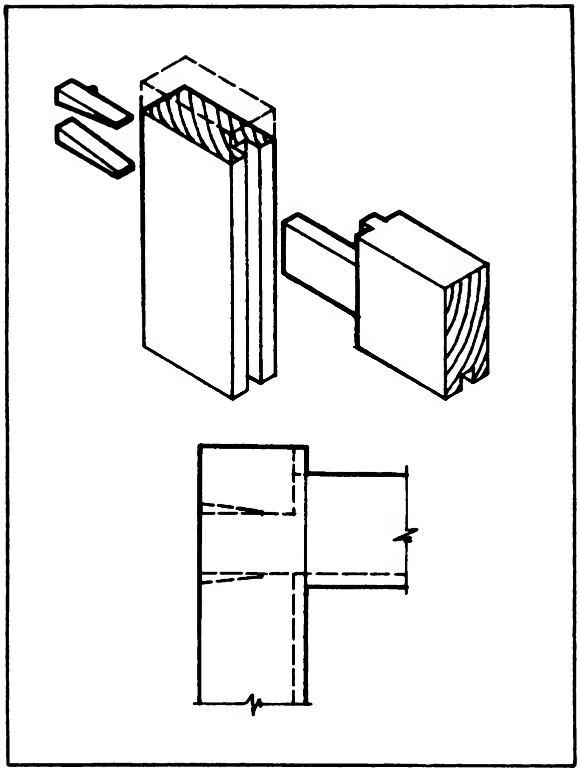


Fig.1 Haunched Mortice and Tenon Joint.

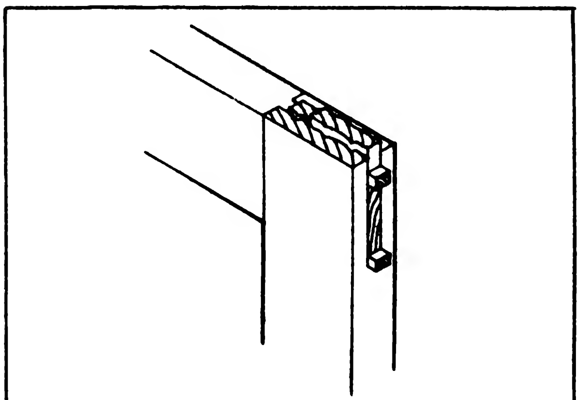


Fig.2 Insufficient Material above Mortice.

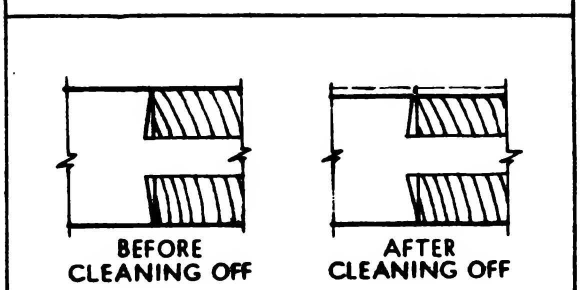


Fig.3 Shoulders Incorrectly Undercut

MORTISE AND TENON JOINTS.

The mortise and tenon joint is the principal joint used in joinery and interior fittings.

While no definite proportions can be laid down as final and binding for all cases met with in practice, the following guiding principles should be closely followed.

(a) The thickness of the tenon should be one third the thickness of the stuff mortised. To facilitate production the mortise is made to the nearest size of chisel available.

(b) The width of the tenon should not exceed five times its thickness. This particularly applies to tenons which are held by wedges.

Where two members are connected by a mortise and tenon joint at a corner, a portion of the tenon is cut away to enable the wedges to hold. The joint is known as a haunched tenon and has a short portion of tenon called a haunch, left on near the root of the tenon, as shown in Fig. 1, to prevent the member twisting.

(c) The width of a haunched tenon should be equal to five ninths the width of the member tenoned. If a greater proportion were given to a haunched tenon the fibres on the member containing the mortise would be inclined to shear when the wedges were driven in, as shown in Fig. 2.

Mortise and tenon joints should be carefully marked out and executed in a methodical manner. Shoulders should not be undercut because when the face of the work is cleaned off, an open joint is exposed, as shown in Fig. 3.

The method of making a simple mortise and tenon joint and its application in framing is shown in Fig. 4. It is good practice to rip the tenon before cross sawing.

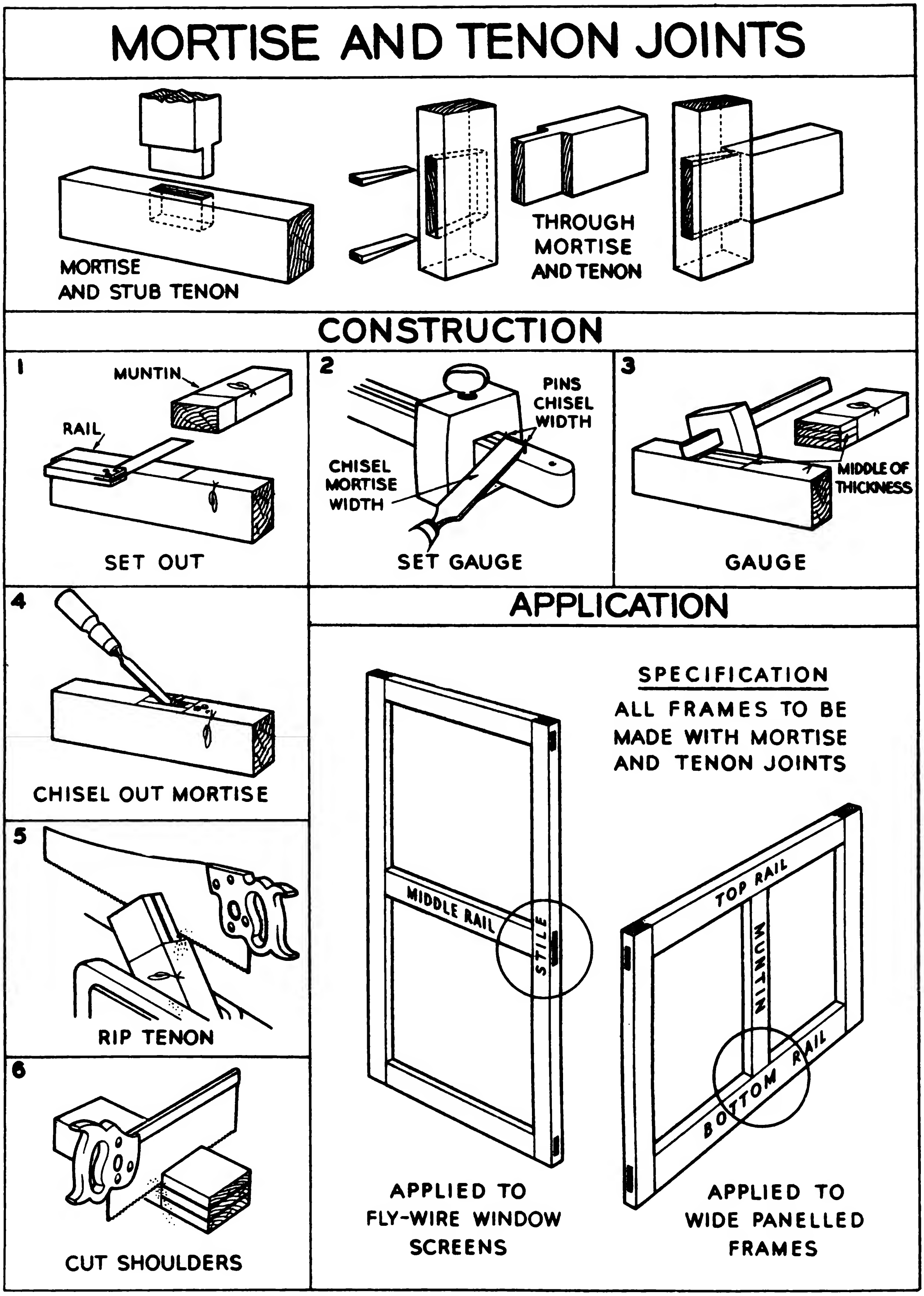


Fig.4 Construction and Application of Mortise and Tenon Joints.

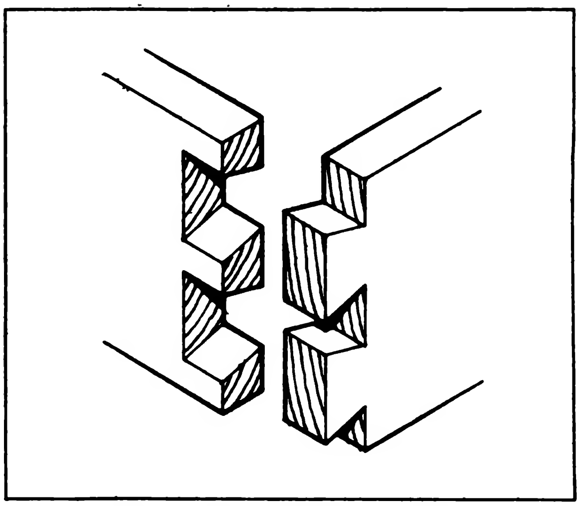


Fig.1 Common Dovetail Joint

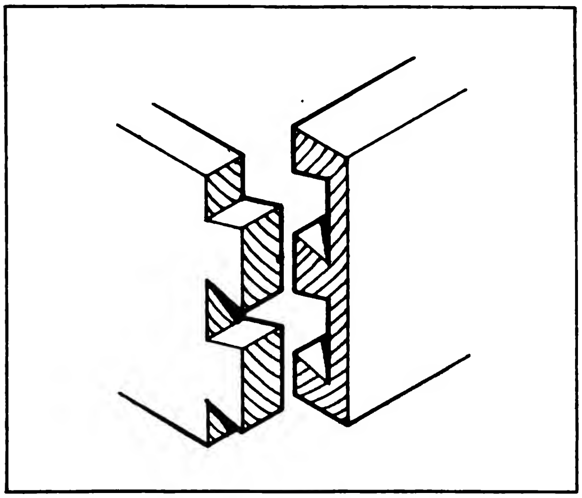


Fig.2 Lap Dovetail Joint.

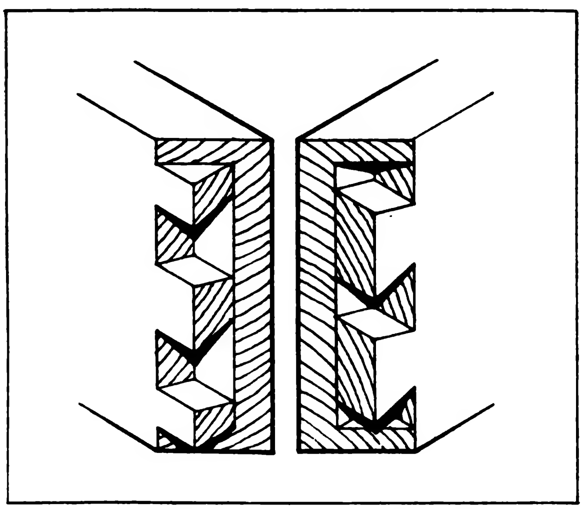


Fig.3 Secret Mitre Dovetail Joint.

DOVETAIL JOINTS.

The strongest type of joint for holding rigidly together the ends of two pieces of timber which meet at right angles to one another is the dovetail joint, of which there are three main types, the common dovetail, the lap dovetail, and the secret dovetail.

A dovetail joint consists in cutting pins in the end of one piece and sockets in the end of the other piece, which are of such a shape as to form a locking device so that pieces can be separated only by a pull in one direction.

The common dovetail illustrated in Fig. 1 shows portions of end grain on both sides. Where this is considered undesirable, as in a drawer front, the lap dovetail illustrated in Fig. 2 is used. In this joint the end grain of one piece is hidden by the laps of the wood over the face. Where it is necessary to hide the end grain on both faces, a secret dovetail, as illustrated in Fig. 3, is used. This gives the appearance of a mitred joint, but because of the expense in its preparation it is only used for good quality work in hardwood.

The method of construction of a common dovetail and its application in the construction of a carpenter's tool box is illustrated in Fig. 4.

The angle or inclination of a dovetail should not be too acute, otherwise there is a danger of the sharp corners breaking off. A satisfactory angle may be determined by setting out 5 or 6 or 7 units of equal length and marking 1 unit at right angles, as shown in Fig. 4. The proportions of the pins to the sockets of the dovetails vary from 1 to 3 for general carcase work, up to 1 to 6, in the case of lighter work.

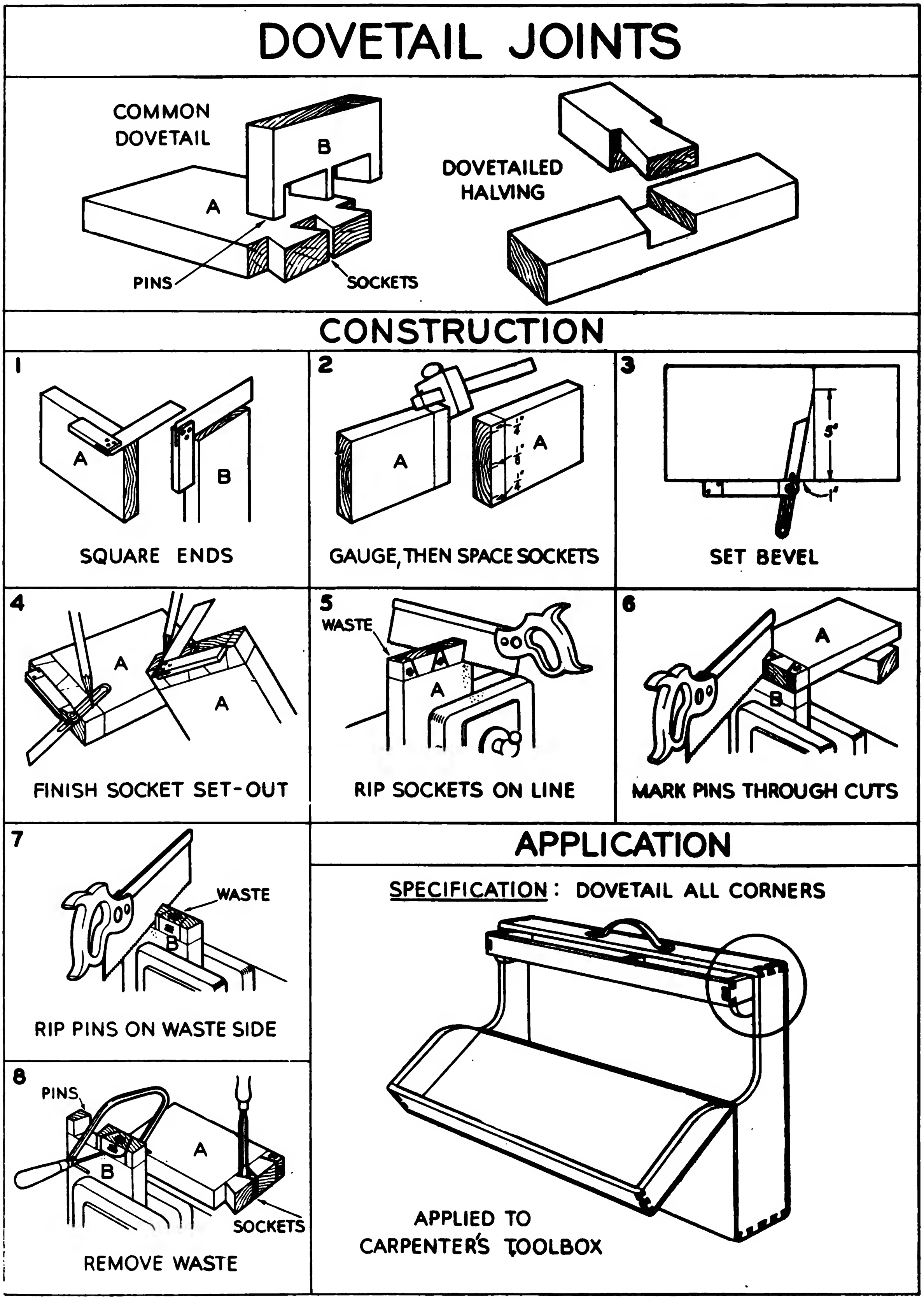


Fig.4 Construction and Application of Dovetail Joints.

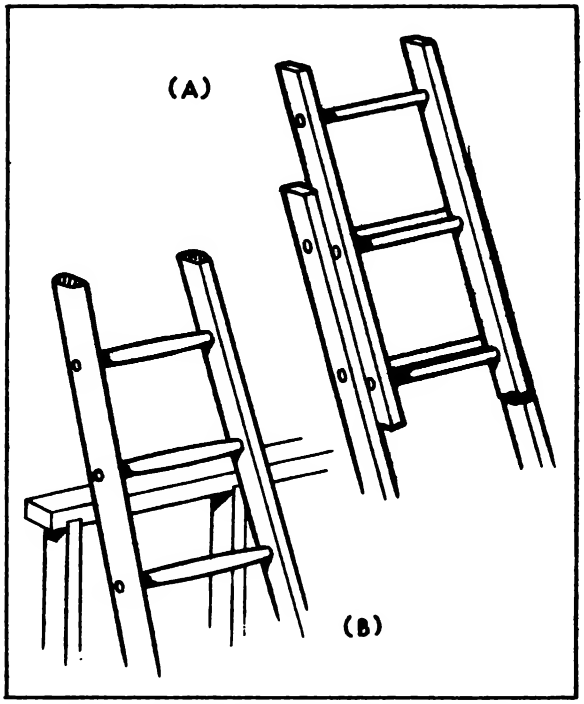


Fig.1 Types of Ladders for Light Work.

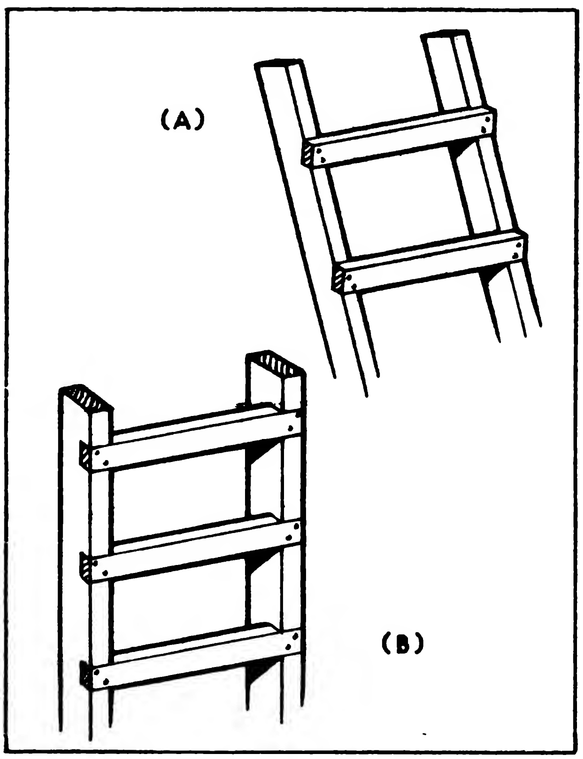


Fig.2 Types of Ladders for Heavier Work.

BUILDERS' LADDERS.

Builders' Ladders are designed to suit different trades. The distance between the centres of the rungs is varied to suit the weight of the materials utilised by the different trades.

A light extension ladder used by painters and electricians is shown in Fig. 1 A. It has parallel sides and rungs at 12" centres. A medium weight ladder used by carpenters and plumbers is shown in Fig. 1B The bottom is heavier and wider than the top. The rungs are at approximately 10" centres.

Heavier ladders as shown in Fig 2A are made for bricklayers, plasterers and roofers. These may be leaned at an angle against the scaffold. The rungs are birdsmouthed into the sides at approximately 9" centres. A heavier type shown in Fig. 2 B, has its rungs housed almost flush at 7" centres. It is lashed vertically to the scaffold. A step ladder is shown in Fig. 3. The cap of all steps is over 12"in length so that a scaffold plank can rest on it without fear of the plank easily slipping off. The treads are longer towards the bottom to improve stability when the steps stand without additional bracing.

The treads are housed ¼" deep into the stiles, all nailed securely together and bound in one or two places either with wire or hoop iron

Plane off the edges of the treads to the set out bevel while in one long length and then cut off the short pieces square across the width and to the spreading bevel in thickness. Pare the inside top faces of the stiles squarely before scribing their housing on the cap. Use screws to fix all the top together.

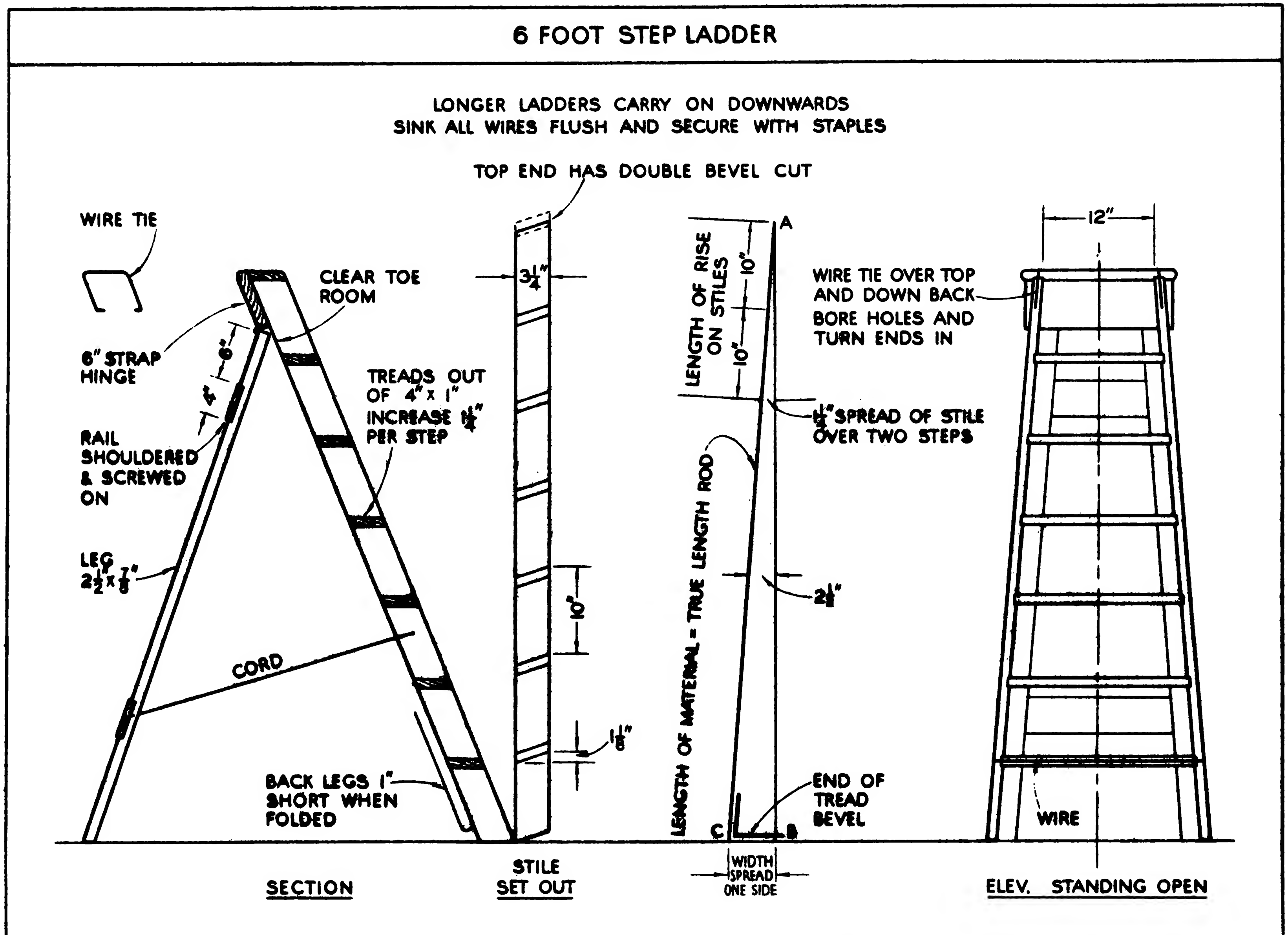


Fig.3 Details of Construction of Step Ladder.

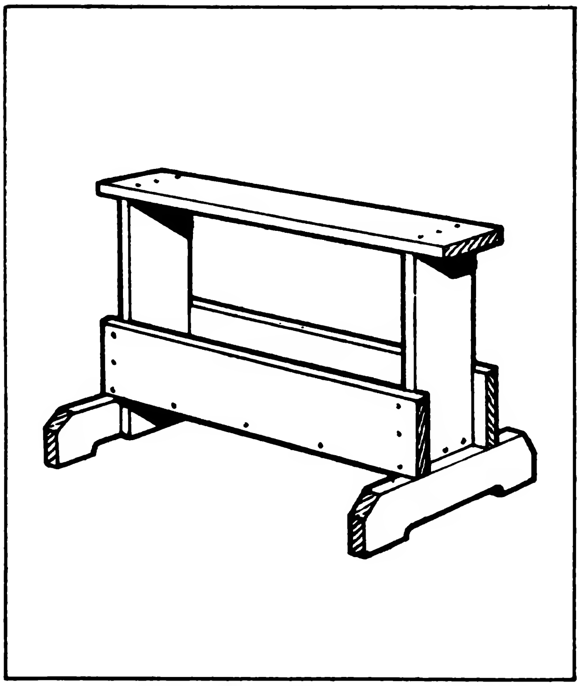


Fig.4 Carpenter's Stool for Indoor Use.

SAW STOOLS.

A handy stool for use while fixing inside work is shown in Fig.4 This can readily be constructed of 6" x 1" and 4" x $1\frac{1}{2}$" nailed together A tray is formed at the bottom and is useful for transporting the small tools required when doing such jobs as hanging doors, fitting sashes and fixing architraves and skirting. This type of stool is not suitable for outdoor work in wet weather as once it becomes wet it is very difficult to dry.

The Carpenter's Saw Stool, illustrated in Fig. 5 is the most suitable stool for outside constructional work and for use in the joiner's shop. It is particularly strong when well made and is easily moved around.

On account of the double slope on the legs a stool is difficult to make without a pattern or some guide to set out the different bevels on the timber.

The illustration gives simple measurements which can be utilised from a steel roofing square or by picking them up with a bevel after drawing them on a board. The bevels are lettered and connected wherever possible with the part where they are to be applied.

Set out the legs in pairs, cut their top ends accurately to the lines, bore and countersink the screw holes. Leave the bottom ends with their lines to be checked after assembling the stool and standing it on a flat floor or bench.

Set out the top with the measurements and bevels nearest the ends. Mark the width of housing from one of the cut legs and after completing the set out and gauge lines, finish all the cutting around the top.

Assemble the stool and scribe the bottom ends to a flat surface before cutting them off.

The cleats which are fitted and screwed to the legs should be made from one piece of timber. It is easier to plane off the two edges of the board while it is in one long length, than it is to handle a number of small pieces. Bevel the two edges of the timber, and then by reversing the face edge, mark out both cleats. This saves a saw cut and economises in the use of material.

Bore and countersink the screw holes and cut off a cleat. The back of the cleat will require fitting to the legs before screwing it in place.

CARPENTER'S SAW STOOL

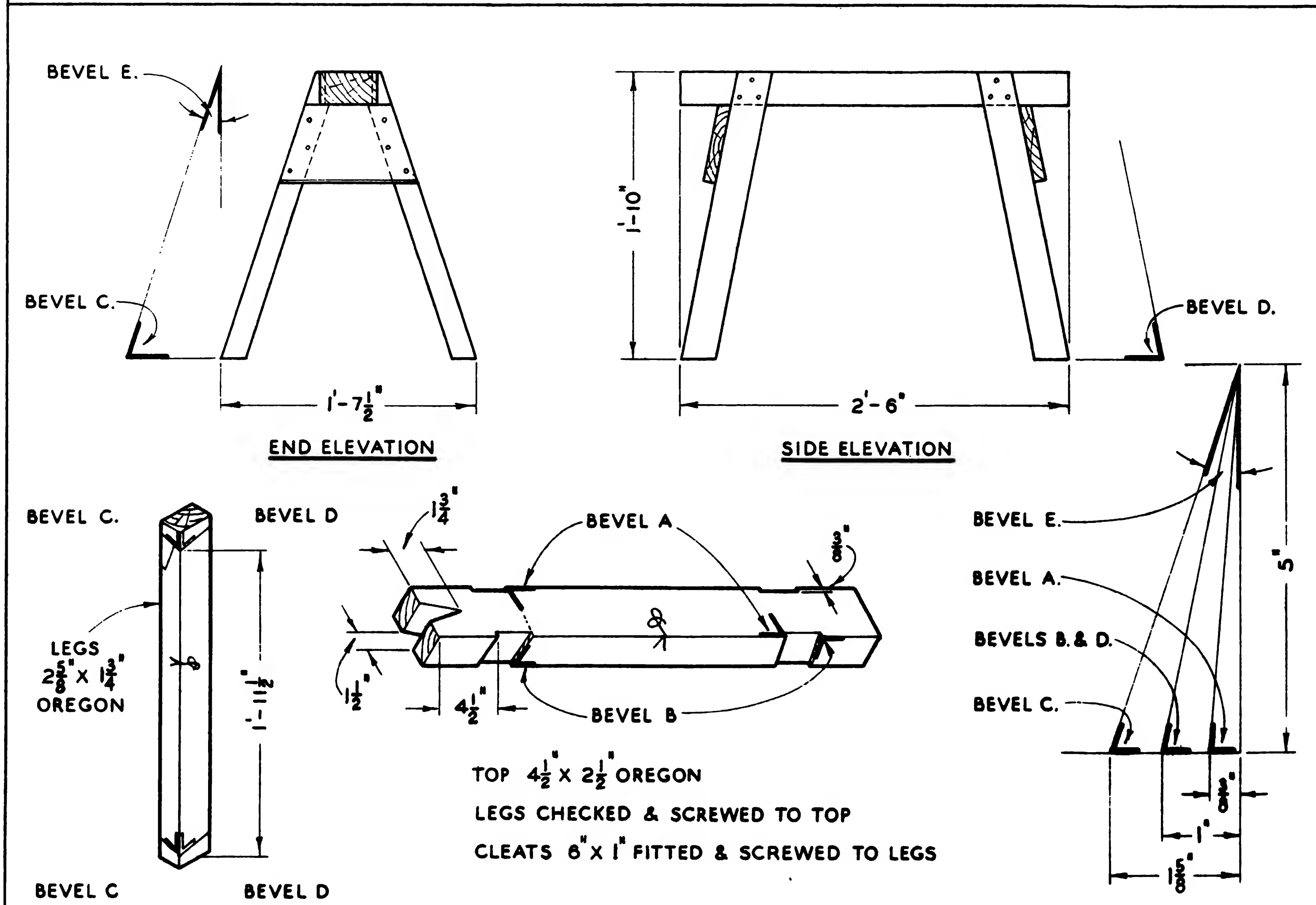


Fig.5 Details of Construction of Carpenter's Saw Stool.

PLANS AND SPECIFICATION.

The erection of a new building involves financial expense on something which at first can only be visualised, but which, when completed, will take a pre-arranged shape. Once a decision has been made on shape and size, and the building is commenced, alterations are difficult to make. We cannot build as we go.

To enable those financing the proposed building to see, as far as possible, what they will obtain, a designer prepares drawings and written descriptions of it, known as the "plans and specification". Even small pieces of "building joinery" or "office fittings" must have some design and specification prepared, before their construction can be commenced. The material and work required for production must be known in advance.

Plans and specification give clear directions to those executing the work, and are used for reference by owner, designer, and surveyor, builder and those employed. Drawings of buildings and written specification include many signs and terms peculiar to the building trade, which must be quickly recognised. Relation between drawings and wording must be established and clearly understood by those executing the work.

THE "PLANS".

The term "plans" is a very liberal one, and at first covers a complete set of drawings. On one sheet may be shown several small scale drawings, and examination of that sheet gives plans for a whole building, showing the work that is planned to be done. Individual drawings on the sheet will be -

(a) Plan.
(b) Elevations.
(c) Sections.
(d) Block Plan.

The position on the drawing sheet of any one of these is purely optional, although wall plan is usually shown on the bottom portion. The scale generally used is 1" = 8', and is commonly referred to as the $\frac{1}{8}$ scale - an abbreviation of $\frac{1}{8}$ inch = 1 foot.

(i) Ground Plan, from its title, shows the overall dimensions of the building, gives names to the rooms and figures for their inside sizes, makes clear the positions of doors, windows, fireplaces, baths, sinks and other fittings. The title "ground plan" is not always used on scale drawings, but is abbreviated to "plan". Plans of a building with several storeys would show "ground floor plan", "first floor plan", etc.

(ii) Elevations show height, width, and finished appearance. Several elevations may be shown, "front elevation", "side elevation", etc., which are measured drawings of what the building presents when "front" and "side" are finished. They give some idea of the slope of land around the building, show height of any steps from ground to floor level, have an outline of doors and windows, and show the style of roof. A sufficient number of elevations is made to satisfy all needs.

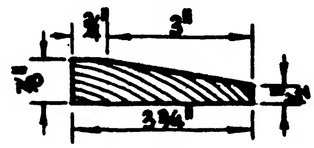
(iii) Cross Sections show constructional timbers, making clear the relative positions of individual materials and their comparative sizes. The lines upon which sections cross the plan are indicated by letters. The positions of the sections are chosen to assist in making construction easy. Some full size dimensions are figured in clear positions to save doubt and time trying to read small measurements from lines, and it is a generally recognised principle that, where they do not agree exactly, these figures have priority over scale drawing lines.

(iv) Block Plan shows the block of land, and, because of large dimensions in suburban blocks, is drawn to a smaller scale than others on the sheet. Its purpose is to plot out the position of the building from the boundary lines. It shows main buildings and outhouses, gates, fences, paths and may include drainage lines.

DETAIL DRAWINGS.

Detail drawings are usually supplied on separate sheets. To the scale of $\frac{3}{8}$" = 1', or larger, they show parts which would be so small in the general building plan that they would be lost. They are the detailed enlargements of those parts. Architects' drawings show titles in bold lettering and dimensions clearly figured. The style commonly used is as follows:-

DETAIL OF ARCHITRAVE
SCALE 3" = 1'0"



THE "SPECIFICATION".

The "specification" is a written detail of type of materials required to be used and work to be done. It is arranged in parts under trade head lines. Special mention is made of sizes and names of material, joints and kinds of finish required. The order of arrangement is in keeping with the entry of each trade into the general progress of the building. Through the specification all trades learn quite early what will follow, and are able to co-operate towards the final result. The whole specification is interlocked with drawing plans and is made to facilitate practical interpretation. The craftsman reads his particular part, enters into the spirit of the design, and does his best to assist in carrying out what is meant to be done.

REGULATIONS FOR BUILDING.

Before the actual work of erecting any building is commenced, permission must be obtained from the building surveyor of the municipality in which the building block is situated. This officer must be satisfied that the structure will comply with local regulations, which prescribe minimum sizes of certain rooms, materials, and distances from boundary lines.

The building surveyor's approval is shown by his signature on the original drawings and specification, which are returned to the builder, and a copy is held by the surveyor. Tracings, dyeline or blue print reproductions are recognised means of copying drawings. The specification is typed in a number of copies. The building surveyor may inspect the work of erection at any stage of its progress to see that no deviation is made from his records.

SEQUENCE OF OPERATIONS.

The work of erecting a timber residence may be divided into stages, which obey a regular sequence and are generally as follows:-

(a) **Structure:**

- (i) Foundation.
- (ii) Floor construction.
- (iii) Wall and ceiling erection.
- (iv) Roof Construction.

(b) **Exterior Finish:**

- (i) Door and window frames.
- (ii) Timber wall covering.
- (iii) Roof covering.
- (iv) Fencing.

(c) **Utility Services:**

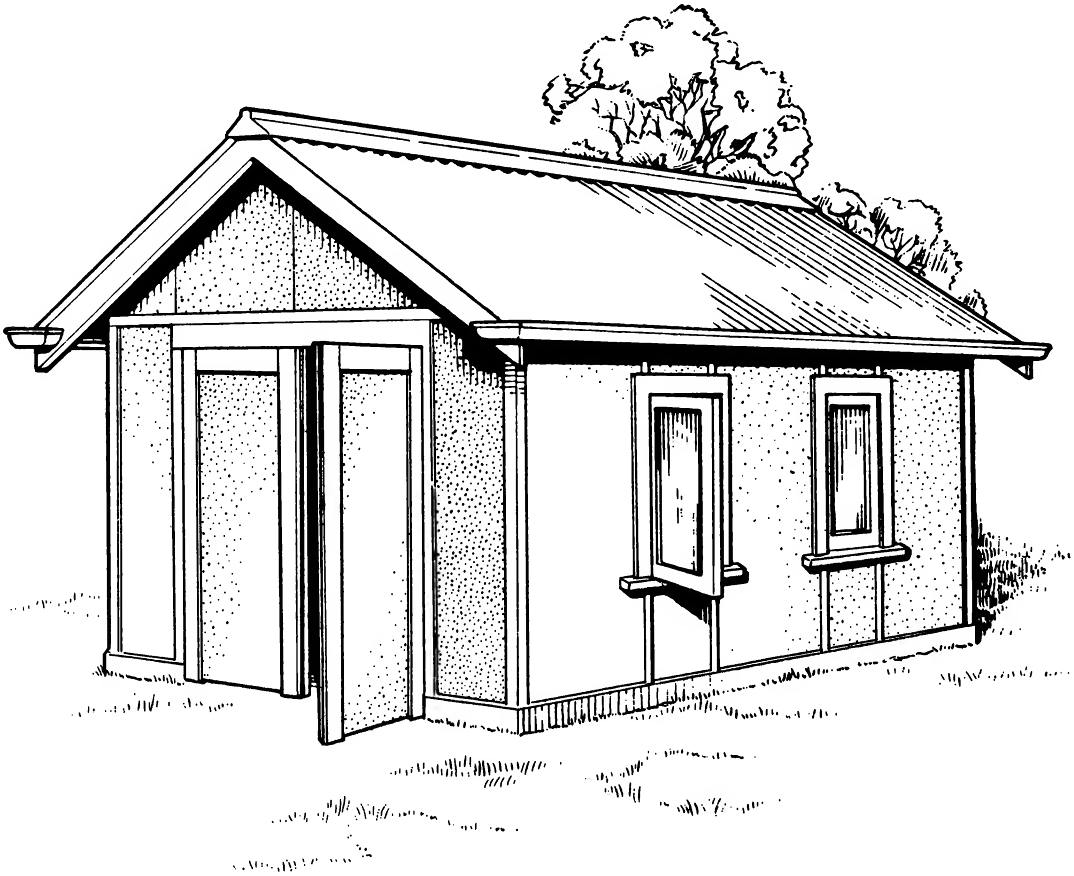
- (i) Electric wires.
- (ii) Sanitary drainage pipes and water supply.
- (iii) Gas pipes.

(d) **Interior Finish:**

- (i) Straighten studs and fix nogging.
- (ii) Fitting and hanging sashes, doors; fitting cupboards; securing sanitary ware; fixing mouldings; setting grates and also wall tiles.
- (iii) Painting and decorating.
- (iv) Installing electrical fittings, and furnishing handles and catches to doors, windows and cupboards.

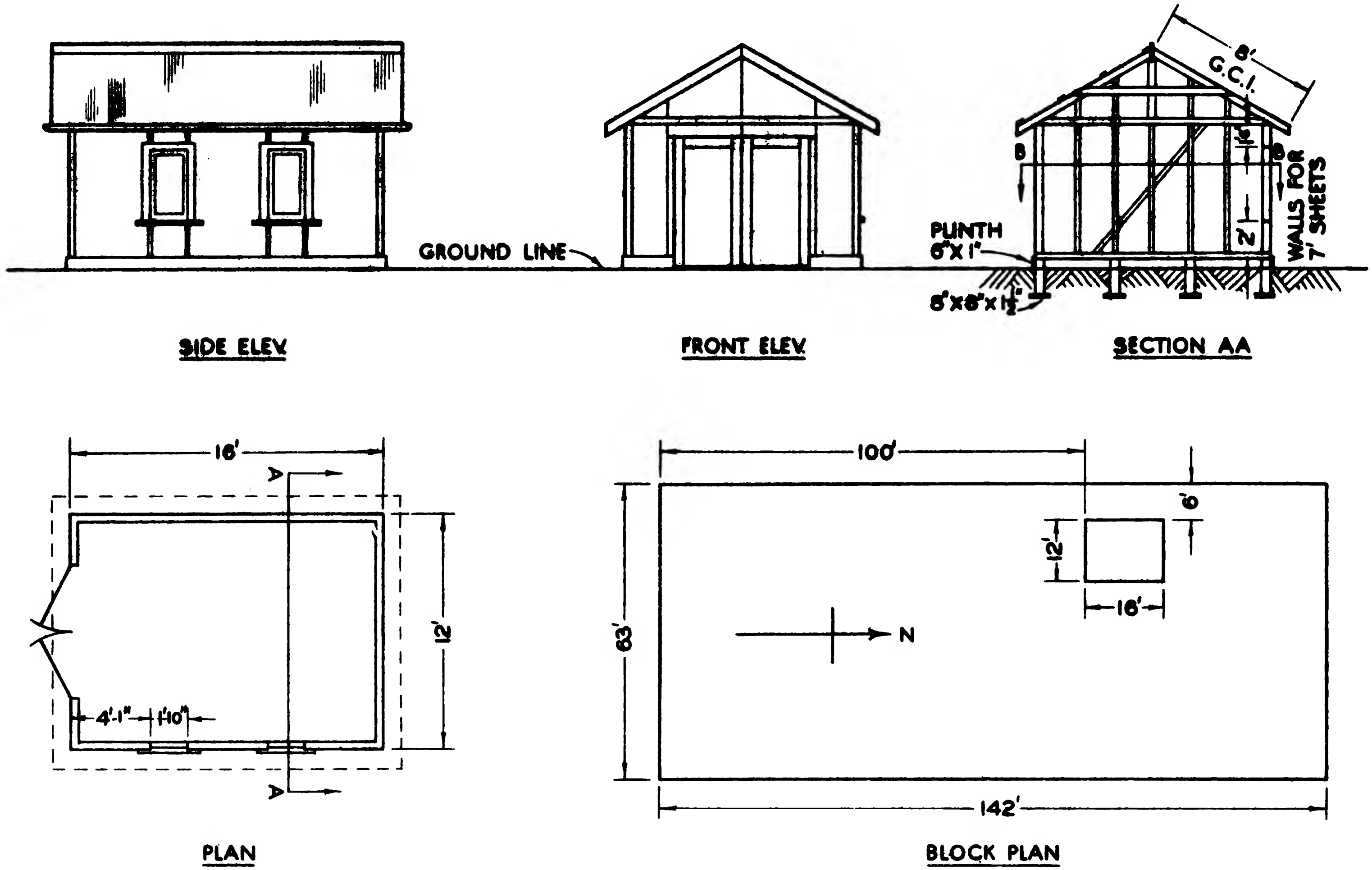
On buildings of lesser importance, such as garages or sheds, where all of the above operations are not required, the work would proceed to completion through the shortened programme.

SECTION 16. ERECTION OF A TIMBER FRAMED GARAGE ON WOODEN BLOCKS



PICTORIAL VIEW OF GARAGE.

TIMBER FRAMED GARAGE ON TIMBER BLOCKS



GENERAL SPECIFICATION.

The specification describes the material to be used in the erection and completion of a garage. The building will have the dimensions shown in the accompanying plan and other detail drawings which are supplied.

The garage is to be a detached timber framed building. The walls are to be covered with fibro cement sheeting, and the roof with galvanized, corrugated iron.

SPECIFICATION OF TIMBER SCANTLINGS.

The specification gives the following particulars of timber scantlings required for the construction of the garage :-

FOUNDATIONS:	Sole Plates	9" x 9" x 1½"	Red Gum or Jarrah.
	Stumps	4" x 4"	Red Gum or Jarrah
	All timbers below ground level must be creosoted or otherwise treated for protection against termites.		
WALLS:	Bottom Plate	4" x 3"	Hardwood
	Top Plate	4" x 2"	Hardwood
	Common Studs	4" x 1½"	Hardwood (not more than 2' centres)
	Window Studs	4" x 2"	Hardwood
	Corner Studs	4" x 2"	Hardwood
	Trimmers	4" x 2"	Hardwood
	Braces	2" x 1"	Hardwood
ROOF:	Rafters	4" x 1½"	Hardwood Not Dressed (not more than 3' centres)
	Ridge	8" x 1"	Hardwood
	Collar Ties	3" x 1"	Hardwood
	Braces	3" x 1"	Hardwood
	Battens	3" x 1½"	Hardwood (not more than 3' centres)
DOOR FRAME:	Head	4" x 2"	Hardwood Dressed
	Posts	4" x 3"	Hardwood Dressed
	Soles	4" x 2"	Jarrah or Red Gum
	Struts	3" x 2"	Jarrah or Red Gum

(NOTE: Other suitable types of timber may be specified.)

MAKING THE FIRST GROUND LINE.

The "Block Plan" on the plan shows the figured size of the land and the position of the garage. Before the building lines can be set out the land boundaries must be found.

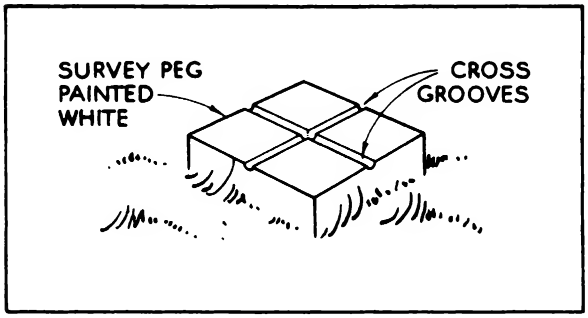


Fig.1 Surveyors' Peg.

The corners of the block are defined by surveyors' pegs. The centre of the surveyors' peg is the intersection of the land boundary lines, and is usually shown by cross grooves on the peg, as shown in Fig. 1. Surveyors drive their pegs deeply into the ground, and although the pegs are originally painted white, they are often difficult to find.

The first building line required is a long one which is parallel to a surveyed boundary line. The drainage fall of the land indicates whether the line nearest to or farthest from the boundary is the better. The building line on the higher ground is the better one to select. For this job, the nearer building line has been selected.

On the street line drive the first stake, with one straight plumb edge exactly 6 ft. from the centre of the survey peg. On the back boundary line at the same distance from the survey peg, drive a second stake plumb.

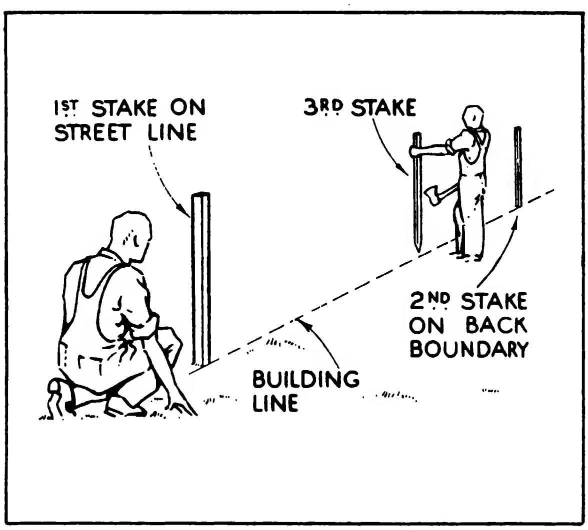


Fig.2 Sighting the Stakes.

In order to have points on the building line close to the work, take a position between the first and the second stakes, approximately 5 or 6 ft. in front of the building line, drive a third stake, as shown in Fig. 2. More stakes may be added if the length of a chalk line from the second to the third stake would be unreliable owing to swaying in the wind.

Between the second and the third stakes, stretch a chalk line near the ground level to establish the No. 1 Building Line. Take care to mark the face edges of the stakes.

The "Building Line" is regarded as the outside line of the wall frame. If the specification requires the outside of the wall covering or the eaves of an overhanging roof to be kept at a definite distance from the boundary line, allowance must be made for it when measuring for the first and the second stakes. Always check the distance with the "Block Plan".

LAYING THE FIRST SOLE PLATES.

Along the Building Line points must be pegged outside the foundation area, so that they are within easy working distance but will not be dug up when the stump holes are made. A convenient distance to keep outside the area is 3 ft. This gives a reasonable working space and is readily measured with a rule. Once a distance is adopted for clearance, it should be used on every job, unless special circumstances do not allow it.

Drive the first building peg into the ground with its centre directly in the No. 1 Building Line, and exactly 97 ft. from the street boundary.

Following along the No. 1 Building Line, drive in a second peg at a distance of 6 ft. more than the length of the foundations, i.e., 3' clearance + length of foundation + 3' clearance, as shown in Fig. 3. Check the distances to the pegs and then partly drive into each peg a 2" nail, to mark points for reference.

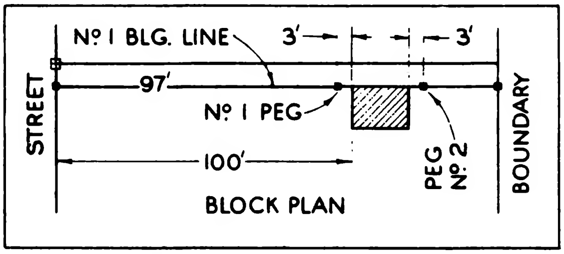


Fig.3 Block Plan showing Building Pegs.

Guided by the Building Line and 3 ft. clearance from pegs, mark, with spade cuts in the ground, the positions to excavate for No. 1 and No. 2 corner stumps. Detach the chalk line and with a spade and crowbar, dig holes of a depth to suit local conditions. Good level bottoms at not less than the minimum depth are required before placing the sole plates in the holes. Plates are then tapped gently into a firm central position.

ERECTING THE FIRST STUMP.

Select a stump with an end cut to suit the sole plate, stand it in the excavation and use its weight to settle the sole plate. Make it stand plumb without support. A turn around its centre line often brings the face plumb. Test it with the spirit level before marking its length to give a top height of at least 4" above the ground. Mark the face, lift on to saw stools, and cut the top square with a hand saw.

Stand the stump centrally on its sole piece, as shown in Fig. 4, and stretch a chalk line between the pegs and test the position of the stump both for line and for distance from peg No. 1. Then fill in the soil around it, and with the head of the crowbar, ram the soil as it rises. If the soil is dry, a little dampening with water will assist in making it firm. During the filling and ramming operation, a stump is liable to rise off its sole plate unless kept down by weight of the foot.

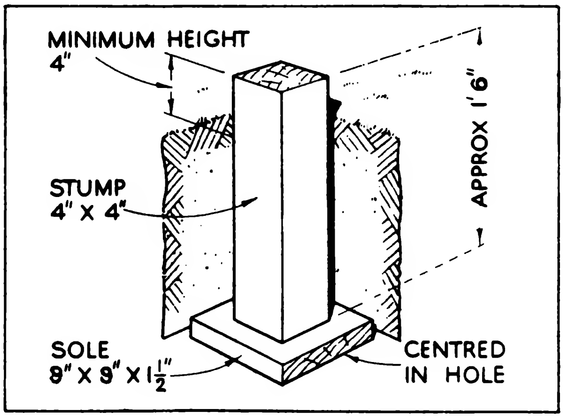


Fig.4 Stump centred on its Sole Plate.

Again test the position of the stump, making sure that it is plumb and that the newly sawn top end is level. The whole line and level of the building will be taken across this stump top in at least two directions.

LEVELLING FOR THE SECOND STUMP.

Stump No.2 is erected at the corner of the foundation next to Peg No.2 and the height of its top will be found by means of a "Line Level". This tool must be used centrally on a good chalk line which is free from knots and stretched tightly between two holds, as shown in Fig.5. The first hold will be on the top outside arris of Stump No.1, where nails will secure the first end of the chalk line. The second hold will be made on a strong stake driven with a plumb edge on Building Line No.1, and erected outside the foundation area.

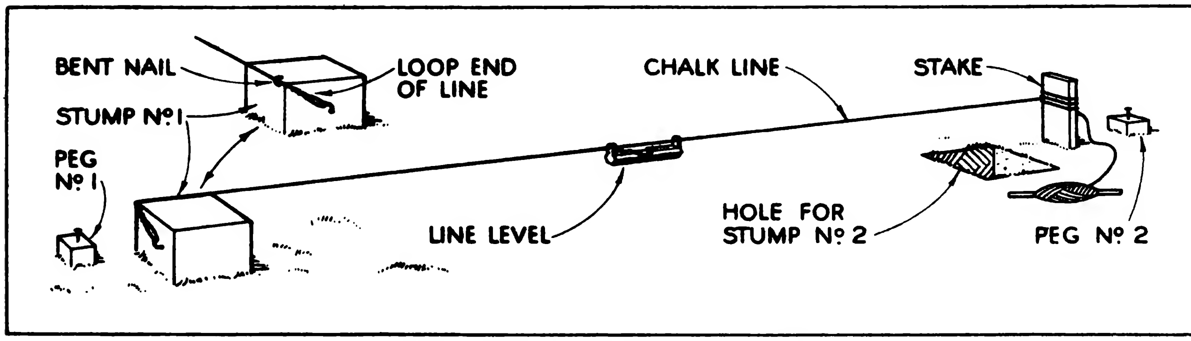


Fig.5 Application of the Line Level.

The level must be attached to the centre of the chalk line before stretching tight. With the line taut, adjust the height of the line on the stake until the bubble in the level registers in the centre of the tube. Mark line height on the stake, release the line to remove the Line Level, and tie it tight again at the height previously marked on the stake. This line is used when measuring the length above the sole plate for marking the end cut on Stump No.2, which will be handled in the same way as No.1.

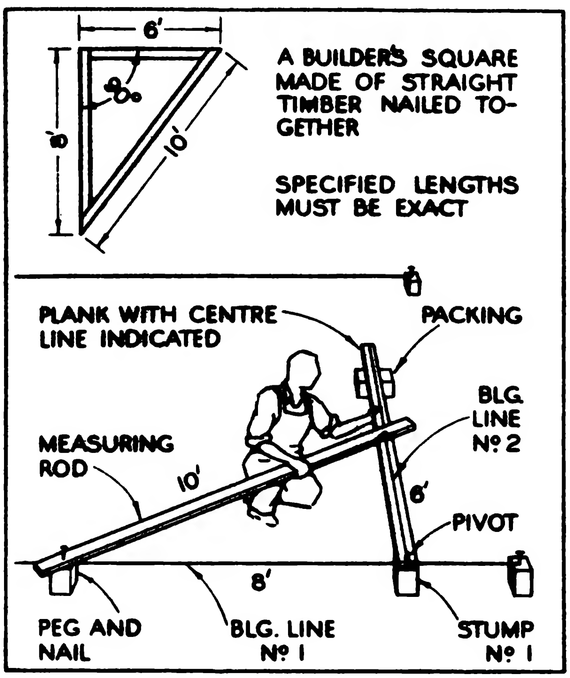


Fig.6 Squaring a Corner.

SQUARING A CORNER.

Corners of buildings are tested for squareness by using the fact that when the three sides of a triangle measure respectively 6', 8' and 10' as shown in Fig.6, the angle opposite the longest side measures 90°.

Commencing at the outside corner of Stump No.1, the Building Line No.2 is required to be at 90° to Building Line No.1. The first side of a triangle will be measured 8' along Building Line No.1, and marked clearly with a peg and nail.

The second side is taken at 6' along a rod which can swing from the commencing point on Stump No.1, and the third side will be a length of 10', taken on either a steel tape or measuring rod swinging from the 8' point until it intersects the 6' point.

Extend along the direction of Line No.2, a distance of 15', (i.e., the width of the building plus 3' working clearance), and drive a peg. Stump No.3 is erected at 3' distance inside this peg, in a similar manner to the Stump No.2.

The correct distance between parallel lines can be measured only when taken square across them. Care must be exercised to do this when making the position of corner Stump No.4.

An additional test for all the corners is made by using the fact that the diagonals of any rectangle are equal in length. As soon as the four corner points are available, test the dimensions of length and width of foundations on parallel lines over the stumps. Then test the diagonal measurement, as shown in Fig.7, and if unequal, make the necessary adjustments before proceeding further.

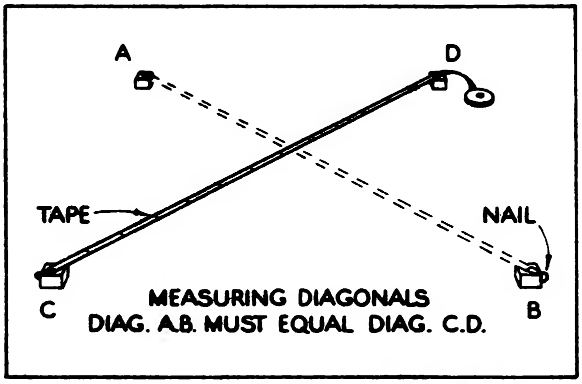


Fig.7 Testing the Lengths of the Diagonals.

"Out of Square" on a building foundation does not always become apparent until the roof is being framed or covered. It is then too late to be altered and has to be "got over", often at serious cost, hard words, and loss of reputation.

COMPLETING THE ROWS OF STUMPS.

With the aid of a rod and line, space out at not more than 4' centres the positions of the intermediate stumps between those on the corners. Take each height separately between the sole plate and the level of a tightly stretched chalk line, and make rows of foundation stumps, as shown in Fig.8. Make sure that every stump is firm and capable of taking its full share of the structural weight it must support.

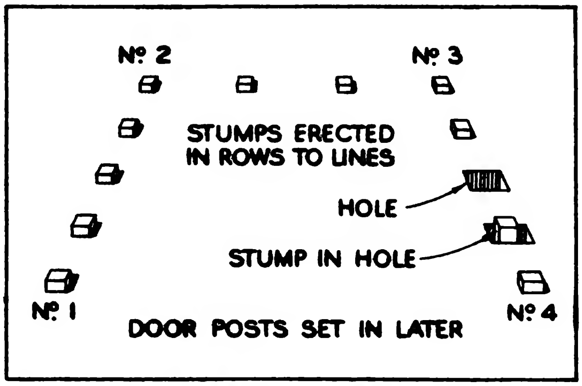


Fig.8 Erecting Stumps in Rows.

An emergency may arise owing to a stump being cut slightly shorter that its required length. Any building up of a sole plate should be a last resort, and only good sand must be used, not loose soil. The better way is to utilize the short stump in a hole further along the line and to cut another stump to correct length. Once the corners are established, give long lengths priority of cutting.

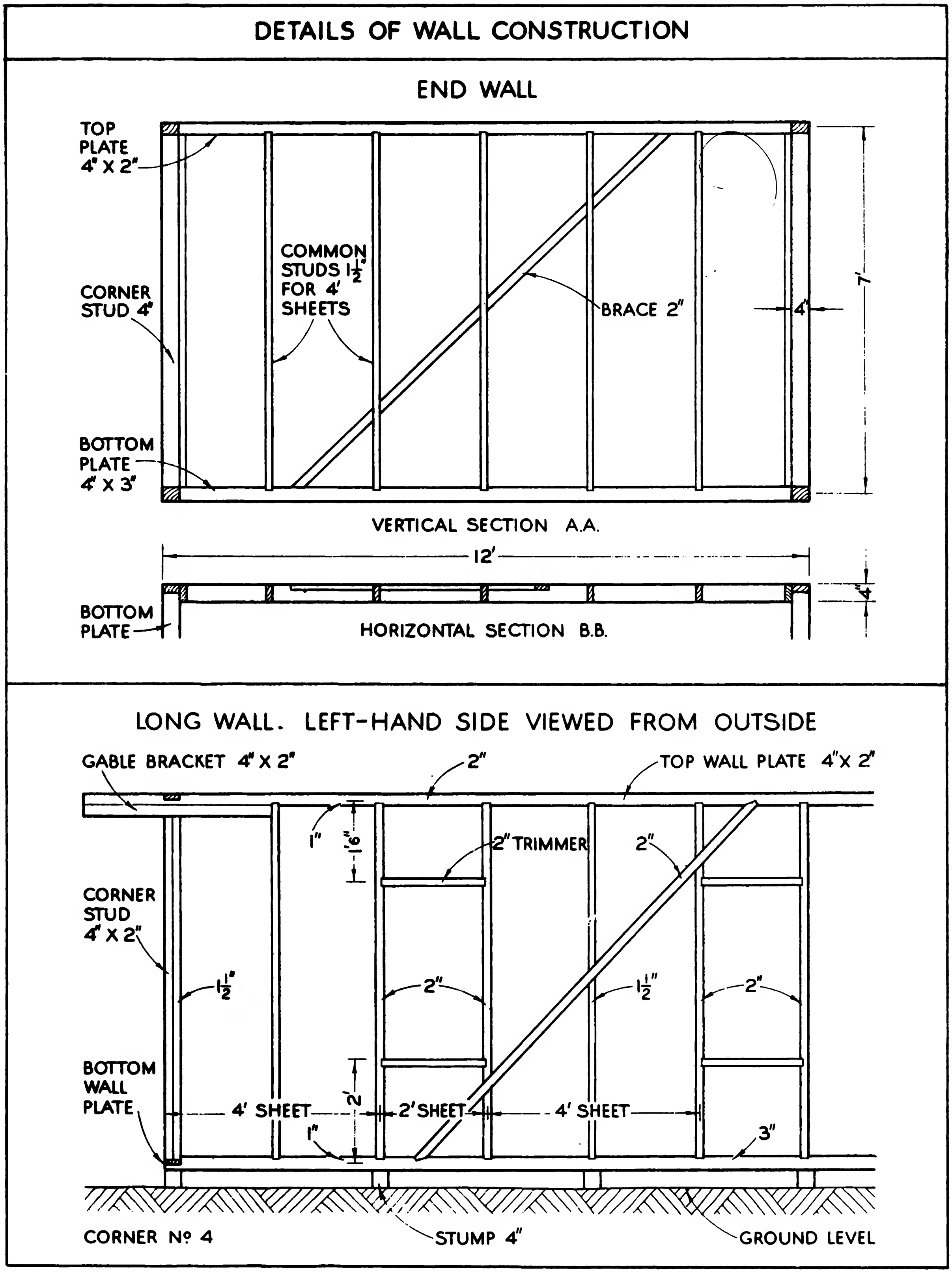


Fig.1 Details of Wall Construction.

STUDY PLAN AND SPECIFICATION.

The first step towards successful completion of any work is to become familiar with the Plan and Specification, which should be always at hand. The drawing should be stretched to its full extent and fixed on a firm backing. A small fillet nailing it to a piece of plywood is a good means of preserving it from loss or damage, and allows easy reading. Keep the drawing in view continually while setting out the walls.

Become familiar with the specification and visualize its requirements. The framing timbers must be correctly placed at door and window openings, and studs spaced to the vertical joints of the standard size wall covering. If in doubt where openings for doors and windows will fit, work it out on a rod and show only the correct lines on the material for cutting.

The majority of building blocks have greater depth than frontage, with the result that buildings are designed with greater length along the side boundaries of the land than width parallel to the street. When setting out wall plates make it a rule to take off the top cheek from all halvings of plates running in the direction of the long side of the building, whether they are long outside walls or short interior walls. Any difficulty that may occur by having to lift a wall through an awkward situation will be more easily overcome than the difficulty of replacing a plate with a halving cheek taken off the wrong side.

Plot out the order of erecting the walls so that no difficulty will arise. A general understanding of this kind greatly assists working progress, and avoidance of errors. Detail drawings of the wall construction for the garage being erected are shown in Fig. 1.

PREPARATION OF PLATES, STUDS AND TRIMMERS.

(a) Preparation of Plates. Select straight timber in lengths required for plates, and mark clearly on face and edge. If a length is curved make the hollow edge face outwards. This is especially done in a garage without ceiling joists, because its middle pairs of rafters when spanning the width of the building will help to straighten the top plates.

Arrange on stools or on foundation stumps, two top and two bottom plates of the long walls, with all edges on one side of the stack in pairs, as shown in Fig. 2. Check the overall lengths and have the centres in line so that the top plates will overhang both ends of the bottom plates. They are placed together to set out four plates in one operation to save time of duplication and to ensure accuracy.

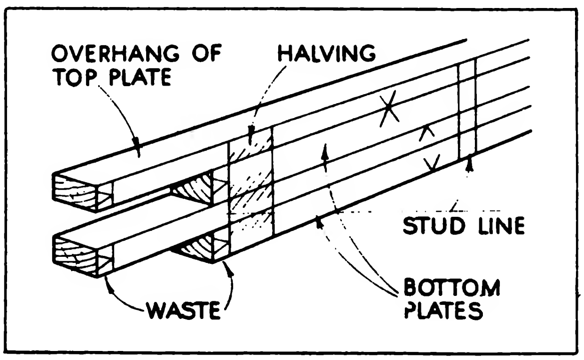


Fig.2 Plates stacked for Setting Out.

Check thickness of stud timber, and then with the aid of a try square and rule, mark out in pencil lines, the saw cuts for housing studs, shoulders of halvings, and full lengths for cross cutting. Square the lines right down the stack. Only when both walls are of similar design will all stud lines suit, but at the ends of the walls all halvings should agree.

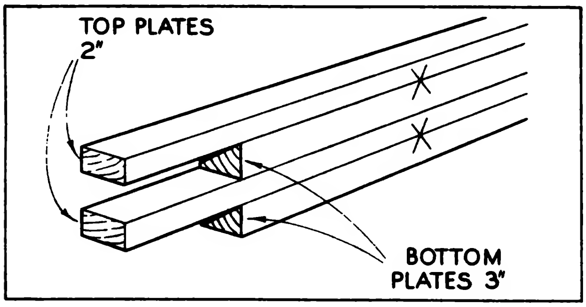


Fig.3 Plates cut to Full Length.

The housing will always be cut out of the back of the material, not the face. See that the pencil lines are on the arris where square lines will commence. Follow up by marking with cross hatched lines on the cheeks of halvings which are to be cut off. In the way they are now stacked, the lower cheek comes off every one. The full length line is marked with an arrow, as shown in Fig.3.

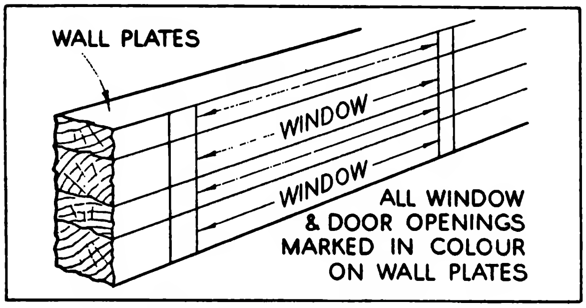


Fig.4 Marking Window and Door Openings.

The positions of door and window openings must be made clear. Coloured marking pencils are valuable for making the important points outstanding. The set out on plates is used to obtain the lengths of trimmers to openings and their positions must be easily seen. The method of marking out is shown in Fig.4.

(b) Cross Cutting and Gauging Plates. Without disarranging the stack, proceed to mark pencil lines square across the top surface of the uppermost plate. It can then be taken aside and cross cut to length. Two different gauge thicknesses are required at parts along the length. The first is half the thickness of the plate for its joints. The second is the thickness of the stuff to be left on when the housing is cut out. On a 2" plate, approximately $1\frac{5}{8}$" is left on. All gauging is made from the face of the timber, to counteract any variation in thickness.

(c) Housing and Halving Plates. Rip saw cut the cheeks of halvings, and with hand saw and chisel cut out housings for studs and plates. Before cutting the shoulders of halving joints check up the width of the timber that junctions with it. Finish up each plate as soon as it comes off the stack and place it on its stump with its partner in the pair.

(d) Preparing Studs and Trimmers. The housed plates reveal the number of pieces required for cutting into common and other studs, and all must be cut to one length. There are several ways of securing a uniform length. It is wrong to cut one length, mark a second one from the first and a third one from the second, and so on. The more this is repeated, the longer the length becomes. Only one pattern must be used, and all other pieces marked from it. Use the best timber for studs, and cut the short trimmers from what is left.

A second method is to cut one end of every stud square across its width and thickness, then use a cutting box made with a stop and saw gauge fixed to length on a long piece of material, as illustrated in Fig.5. When a large number of studs have been cut, the saw gauge will become worn and need renewal. Studs for the door and the window openings are set out for trimmers.

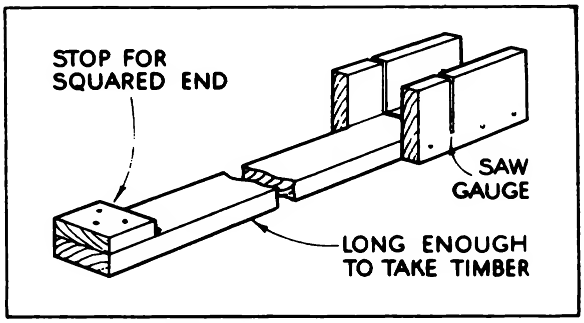


Fig.5 Cutting Box.

Check the height from sills to plates, measure the heights of frames, allow room for packing, and cut from the face of the stud a depth of $\frac{3}{8}$". Trimmers and cantilever brackets are cut to length measured on the top plate. This completes the preparation of members for the wall framing.

ASSEMBLE AND TEMPORARILY BRACE.

With all wall members prepared, select a suitable position on the ground, and lay spare timber as sleepers on which to rest the plates while nailing the studs. See that the sleepers have no twist. Work with their face edges upwards, and with the exception of the corner studs, nail together all the studs, trimmers and plates to make wall frame No.1.

Keep top edges of studs flush with plates. Maintain as square an outline as possible during nailing, and on completion make the frame square by having diagonal measurements equal. Straighten the plates and the studs and tack the wall brace over its true position. Scribe the width of the brace directly across the edges of the studs and plates. Gauge the neat thickness of the brace from the edges of plates and studs, and cut housings from them to allow the brace to be nailed down flush with the face of the frame. Cutting the brace across the plates gives easier working and takes very little strength from the junction. Nail the brace securely to the top plate and tack it to other housings. Its final nailing and cutting to length are made after the erection of the frame.

Lift the assembled frame into position and nail to its foundation blocks, holding it upright by bracing from blocks of other walls. Carry on in the same order until all wall frames are erected and temporarily braced. The corner studs and joints in the plates are fixed as the work proceeds.

ERECT PLUMB AND FINALLY BRACE.

The test before finally bracing wall frames into position is made at the corner with a plumb bob and line. The line is suspended alongside the whole height of the frame.

To hold it to the top plate a short piece of batten is prepared with a saw kerf in its end to take the line, and a nail which projects from the under side for a gauge, as shown in Fig.6.

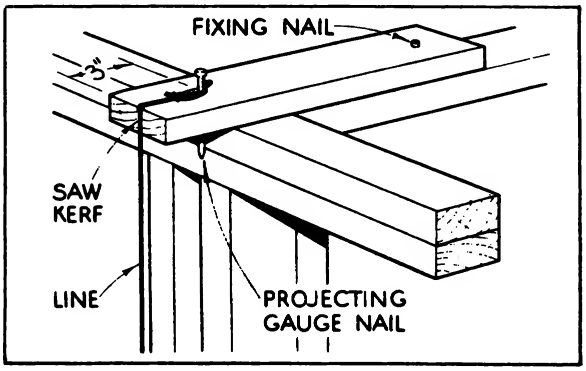


Fig.6 Plumb Line Gauge.

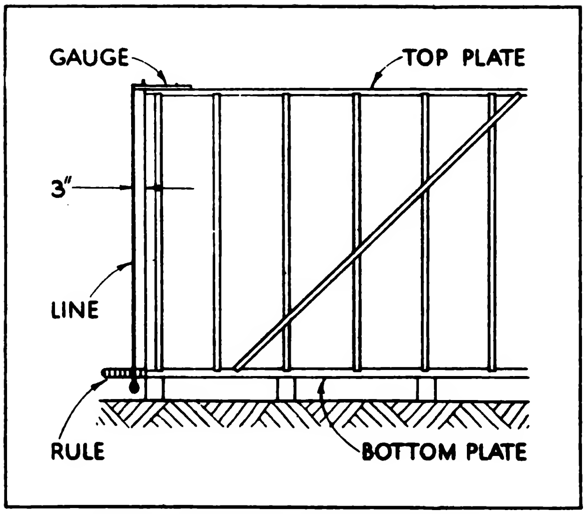


Fig.7 Plumbing the Wall Frames.

This line gauge is nailed to the top of the top plate, keeping the projecting nail against the outside edge of the plate. A rule is used against the bottom plate to check the 3" measurement of the plumb line.

Any adjustment of the frame is made before finally nailing the brace into the frame, as illustrated in Fig. 7.

This operation is repeated at the other corners until all are plumb, and is followed up by nailing stretchers across the long plates to keep them parallel.

THE DOOR FRAME.

Materials ordered to specification for the garage door frame are :-

Head.	4" x 2"	Hardwood	Dressed 4 sides	Finish	$3\frac{3}{4}$" x $1\frac{3}{4}$"	1/8'
Posts.	4" x 3"	Jarrah	" 4 "	"	$3\frac{3}{4}$" x $2\frac{3}{4}$"	2/10'
Soles.	4" x 2"	Jarrah				2/3'6"
Struts.	3" x 2"	Jarrah				4/3'
Battens.	4" x 1"	Hardwood				2/7'

The members are prepared as a frame on the site and placed together in convenient sequence.

Tops of posts are cut out to hold head of frame which is nailed in place after posts are erected.

Underside of head is shouldered $\frac{3}{8}$" deep to keep correct distance between posts when the weight of the doors is hinged on to them.

Bottom wall plates are housed into backs of posts and skew nailed in position.

Posts are housed into sole plates. Struts are cut to fit diagonally between post and sole.

Batten, sole and struts are nailed to post.

PREPARATION OF MATERIALS.

(a) Excavations. The position of each post hole is marked on the ground, large enough to take the full length of the sole. The set out on the bottom wall plate gives the distance from the corner stump. The excavation will be to a good firm level bottom at a depth of not less than 2'6".

(b) Soles. In the centre of the face of the soles, cut housings to a depth of $\frac{3}{8}$", and with a length to fit the finished width of the posts ($3\frac{3}{4}$").

(c) Battens. Sheathing battens are cut to the exact height between the top and the bottom plates of the erected wall frame. This distance is measured at the corner stud. The battens are to give nail fixing for the sheeting which finishes alongside the door posts, and must be ready for use when those posts are being set out.

(d) Posts. Mark the faces and edges on the posts and square cut the top ends separately, removing any faulty timber in the off cuts. As the depths of excavations often differ, the full length of each post must be taken individually. A suitable method of doing this is as follows:-

Place the sole piece in the hole, as shown in Fig.8, and ram it down. The batten is tacked on later to assist in lifting the sole out. Prop the top plate up straight with a "tom" and measure the length of the post on a rod, as shown in Fig.9. Note that the face of the post goes towards the door and the edge faces the weather. Make sure that the posts are marked with lengths to suit the right hand and the left hand sides of the doorway.

Cut the posts to length and set them out as shown in Fig.10. Cut the sheathing batten to the height between the top and bottom plates, mark it accurately from its top end with the width of the head of the door frame, then use it as a marking rod. Keep it $\frac{1}{8}$" below the top of the posts for housing them into the place. The shoulder lines for cutting out the posts are marked $\frac{1}{4}$" above the head line on the batten as shown at "A". The lines for housing the bottom plate are marked as shown at "B". Mark with an "X" the waste to be cut out.

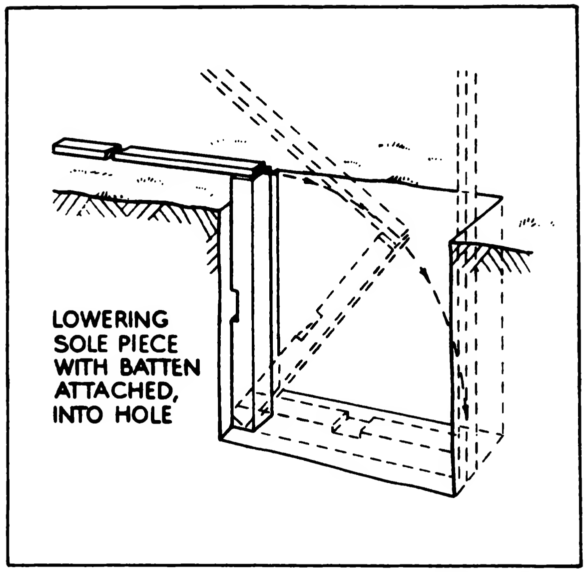


Fig.8 Placing the Sole Piece in the Hole.

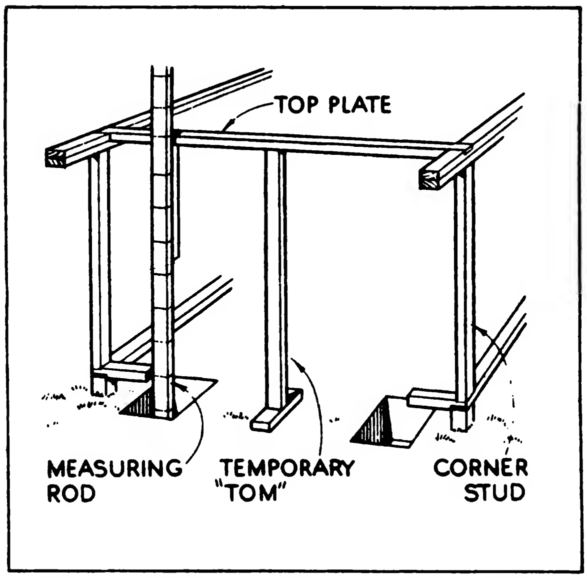


Fig.9 Measuring the Height of a Door Post.

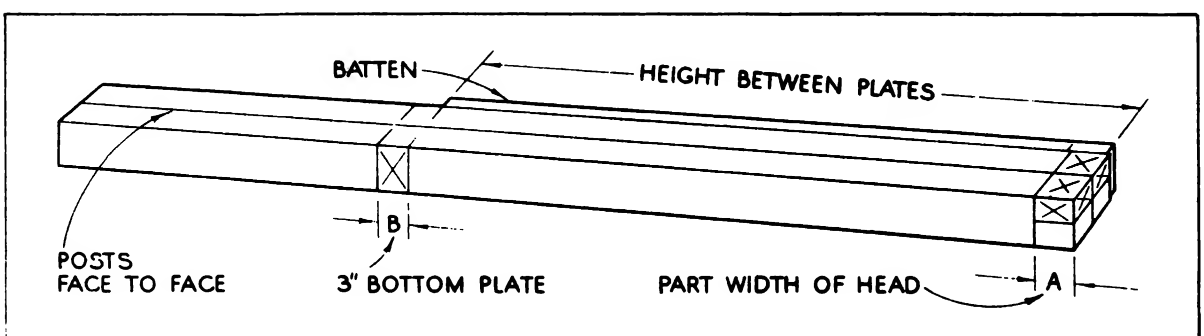


Fig.10 Setting Out the Cuts on the Door Posts.

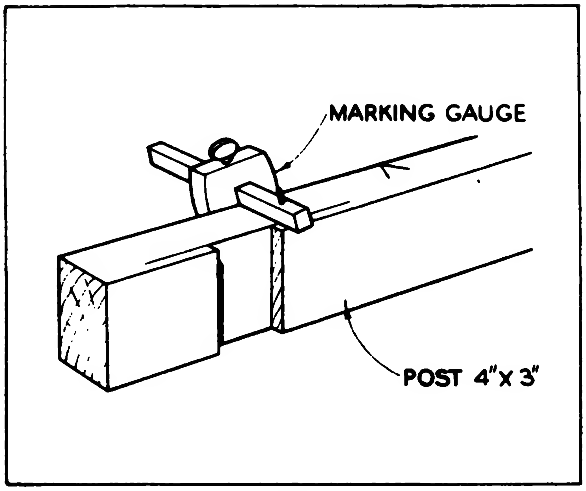


Fig.11 Gauging from Face at Bottom of Door Post

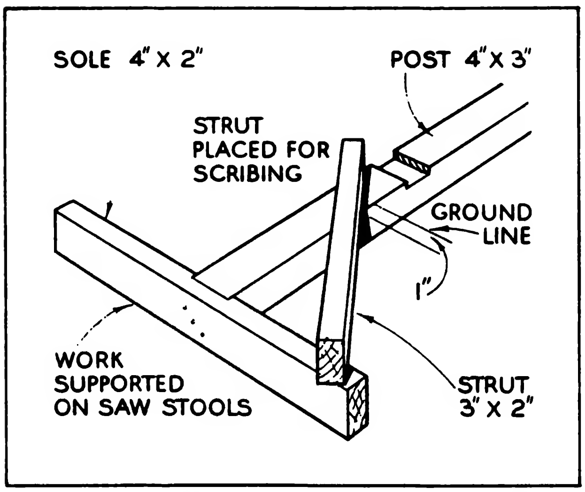


Fig.12 Determining the Pattern for the Struts.

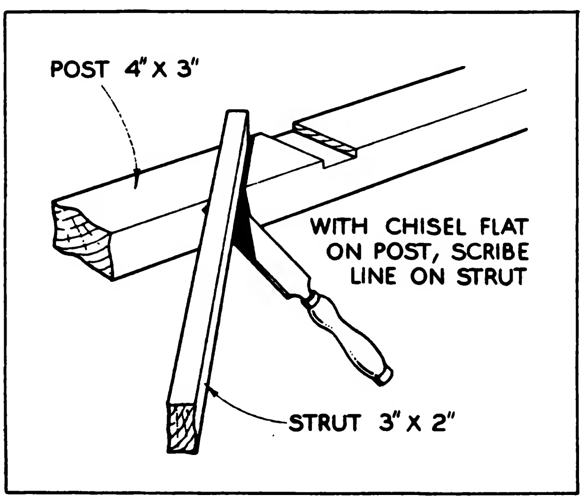


Fig.13 Scribing Cutting Lines on the Pattern.

At the tops, gauge from the outside edge the full thickness of the head, making a continuous line on two sides and around the end.

At the bottoms, as shown in Fig. 11, gauge from the face of the post the thickness to remain on the post after cutting out the trench. The approximate depth of the trench is $\frac{3}{8}$".

First cut the top with a rip saw on the waste side of the gauge line. Cross cutting the shoulders with a hand saw is delayed until the posts are erected, to allow checking of the line of shoulder. Next cut out the trenches for the bottom plates.

(e) Strutting Posts. Splayed cuts on a number of struts are marked from a pattern. The pattern is obtained when it is the third side of a right-angled triangle, as shown in Fig. 12. The sole piece nailed in position gives 90 degrees from both sides of the posts. The pattern strut is marked in one angle.

First mark on the post a height 1" below ground, to show the top level of the strut, then lay the strut material on edge across the angle between the post and the sole to scribe the cuts.

To scribe the cutting lines, use the corner of a long chisel, as shown in Fig. 13. Lay the face of the chisel flat on the sole, and again on the post to guide the chisel lines.

Cut the pattern square through the width of the stuff on the splay line scribed across its thickness. Before making others from it, test cuts by placing pattern in the angle.

A choice of two methods may be made to facilitate nailing through the struts. One is by cutting splayed saw kerfs, as shown in Fig. 14; the second is by boring holes with a brace and bit.

When fixing the struts to the soles, force must be used directly against the nailing point to prevent the strut creeping along the sole.

Fixing the struts to the post may be temporary to allow adjustment when the post is being "plumbed up".

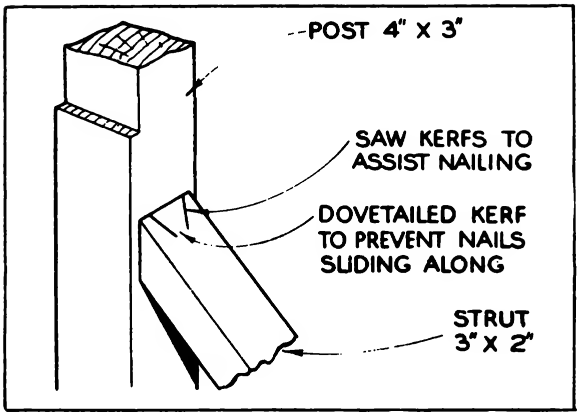


Fig.14 Junction of Strut and Post.

(f) Head. The full length of the head will cover the overall thickness of two posts and the width of the doors. The ends are square cut. When selecting the face and edge of the head, look along its length and work towards any hollow edge with the face and edge marks. This is done so that when the head is finally fixed it will have a cambered (arched) line over the doors. Square shoulders are sawn on the underside of the head to fit against the posts and ensure correct width of door opening.

ERECTION OF DOOR FRAME.

Each post is erected singly in its excavated hole and tacked to the top plate of the wall at lines already set out. The face of the post stands outside the plate line by the thickness of the wall covering ($\frac{3}{16}$"). The line of the bottom of the posts is "plumbed" by sighting the whole post true with the corner stud, and then the hole is filled and rammed tightly.

Test the line of shoulders on the posts before fixing the head, and depth of housing. House in the top plate for post and finally nail all together. The sheathing battens are nailed on the posts, keeping them to the wall line, and the bottom plate is secured by skew-nailing. The brace in a short length of wall is given two directions, as shown in Fig. 15, to keep its angle from becoming too steep, otherwise it will be ineffective.

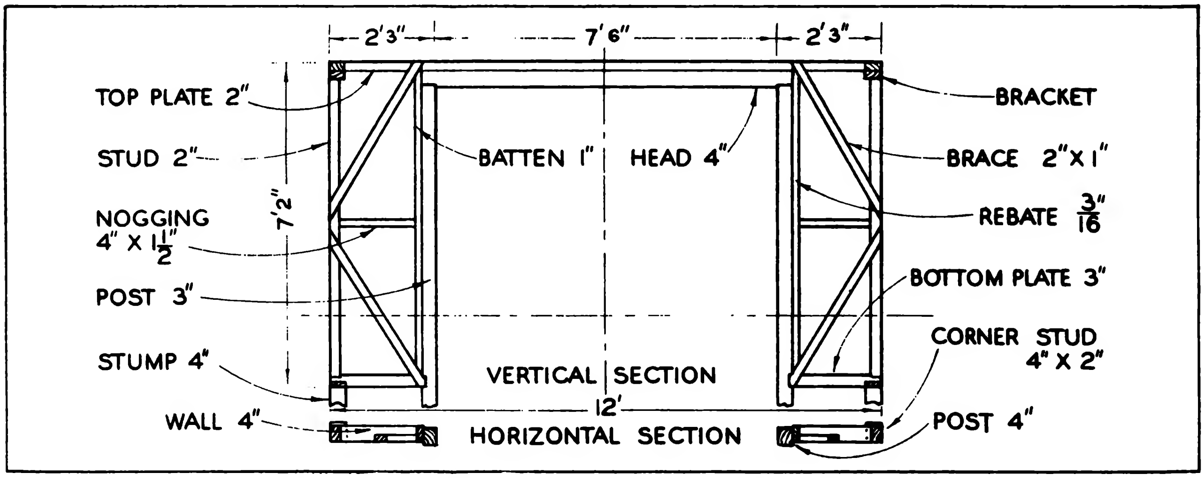


Fig.15 Construction of Door Frame and Front Wall.

MATERIALS FOR ROOF FRAME.

Materials ordered to plan and specification for roof frame are as follows:-

Ridge	8" x 1"	Hardwood	1/18'
Rafters	4" x 1½"	Hardwood	9/16'
Collar Ties	3" x 1"	Hardwood	3/6'
Braces	3" x 1"	Hardwood	4/11'
Battens	3" x 1½"	Hardwood	8/18'

Roof to suit 8 ft. corrugated sheets. No soffit lining or dressing provided for roof timbers.

GABLE ROOF.

The triangular piece of wall which extends vertically above the top plate to underneath the roof is known as a "Gable". A "Gable Roof" is a roof which makes a gable at its end.

Three common methods are available for setting out the lengths and bevels of roofing timbers. Points in one method which are easily understood by one man are not always apparent to his neighbour, and practice in all methods gives greater opportunity for bringing together good understanding and confidence, which results in expert execution. The three methods are all based upon the same facts and produce the same result, but differ wholly in the tools used. The three methods are as follows :-

(i) On the Ground. Full size materials are laid out on the ground, and measurements and bevels marked directly on to patterns. Ground space is required for this method.

(ii) Scale Drawing. Detail drawings are made. Measurements and bevels are picked up from the drawings and transferred to the material. Facilities for drawing are required, and great accuracy must be employed.

(iii) Steel Square. A special roofing square is required. From its graduation, lengths are worked out, and the fence adjusted for the bevels.

RAFTERS.

The names given to the three sides of a roof triangle, as shown in Fig. 1, are as follows :-

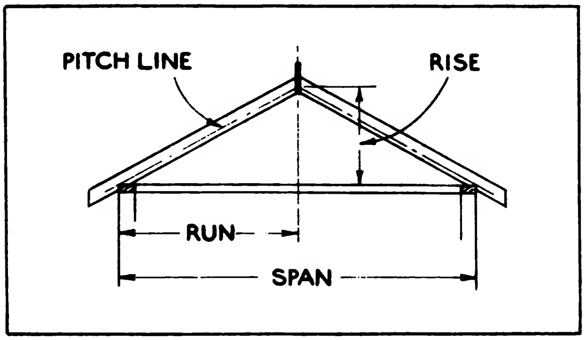


Fig.1 The Roof Triangle.

(a) The Run, which is the base of the triangle and is half the length of the span of the roof.

(b) The Rise, which is the height of the triangle, measured at the centre of the span.

(c) The Pitch Line, which is the hypotenuse of the triangle.

The Run and the Rise always meet at an angle of 90 degrees.

SETTING OUT RAFTERS ON THE GROUND.

The clear ground at the rear end of the erected wall framing is used for setting out and the foundation line is made the base for work. Two lines at right angles to the base are required. The method of setting out these lines is shown in Fig.2.

Line No.1 is at the bottom of the set out, and is stretched parallel to the long wall of the building, at 1'-1¼" outside its foundation.

(1'-1¼" = 12" overhang for rafter, plus 1¼" projection of sheeting to give water "Drip" into spouting.)

Line No.2 is the centre line of the building extended not less than 4' past base. Parallel to this line a straight edge is fixed at half the thickness of the ridge (half of 1") away from it.

The three lines are all parallel.

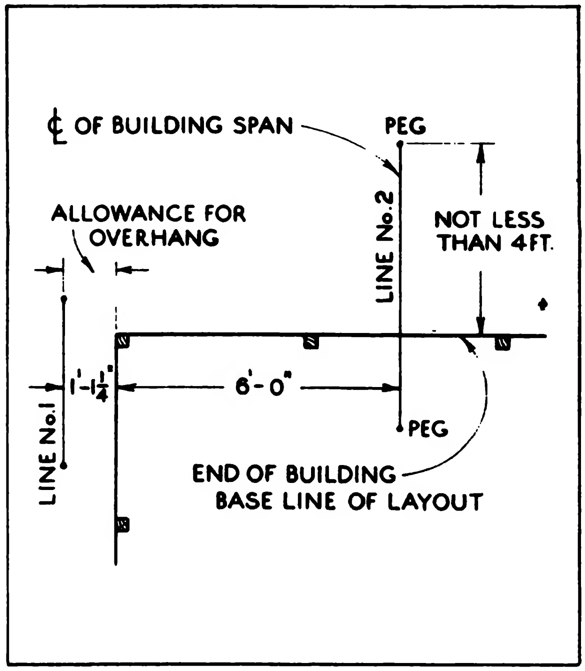


Fig.2 Setting Out the Run and Position of Rise.

The length of the rise is found by the use of a measuring rod, as shown in Fig.3. This rod has marked on it a length of 8 ft., which is the length of the roofing sheet.

The method used is one of trial and error, in which a distance of 8' must be placed obliquely between Line No.1 and the ridge line, which is indicated by the edge of the straight edge. The rod must also touch the corner of stump at the end of the base line.

The rise may then be measured from the base line along the straight edge to the top end of the measuring rod.

The measuring rod now makes the pitch line, which must be marked on the straight edge before the rod is removed.

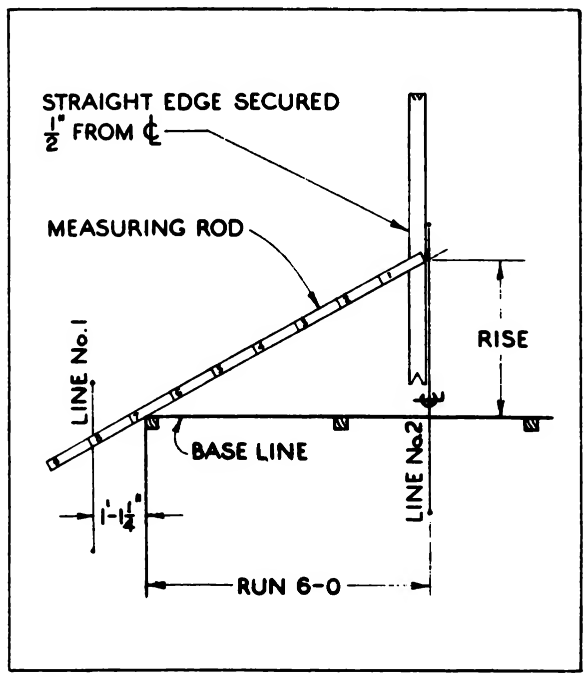


Fig.3 Determining the Length of the Rise.

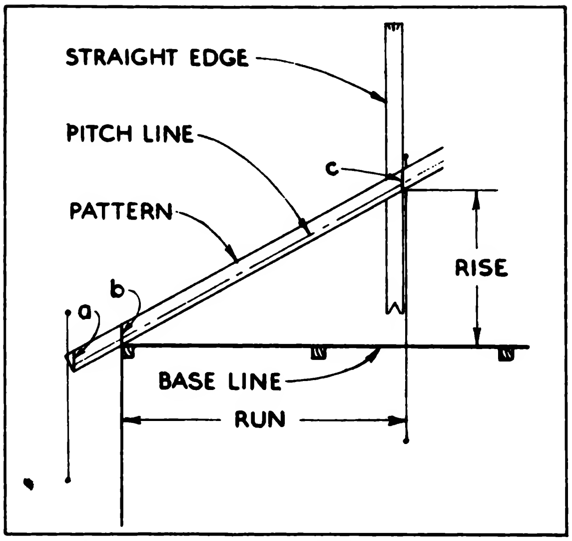


Fig.4 Setting Out the Pattern Rafter.

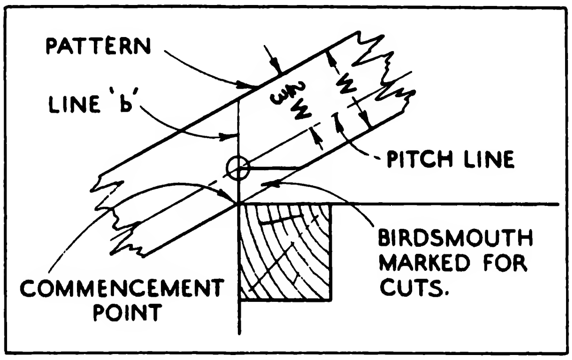


Fig.5 The Birdsmouth Cut.

MARKING THE PATTERN RAFTER.

Lay the timber for the "pattern rafter" in place of the measuring rod on the set out triangle, and mark on it three parallel lines, as shown in Fig.4.

(a) Commencing at the bottom end mark one line parallel to and $1\frac{1}{4}$" inside the chalk line of the set out.

(b) Mark the second line as a continuation of the outside Building Line.

(c) Mark the third line directly above the line of the straight edge, which makes $\frac{1}{2}$" thickness of ridge.

These three lines give direction of the plumb cuts.

Birdsmouth Cut is the name given to the shape cut out of the bottom of roof timbers. Two saw cuts are necessary, one to fit on top of the wall plate, and the other to fit against the outside vertical edge of the plate. The lines for these cuts intersect on a point two thirds of the distance down Line "b". This line is a continuation of the outside Building Line and the Line "a" is at right angles to it, as shown in Fig.5.

THE RIDGE.

The length of the ridge is the same as the top plate, and the following are its collected dimensions :-

Overhang at two ends	= (1' x 2) =	2'	Total = 18'
Length of wall frame	=	16'	

The positions of the rafters along the ridge are marked with one square line and a short tick against it to indicate on which side of the line the thickness of rafter must be fixed, and marked also on top plates. The first rafter is flush with the end of the ridge and the next is 12" away, to finish directly over the end wall line. The other end of the ridge is marked in the same way and other rafters are spaced equally in the remaining 16'. The specification demands that centres shall not be more than 3', and as 16' is not a multiple of 3, the spaces must be less than 3'. The exact measurement to space out is 15' $10\frac{1}{2}$", i.e., 16' minus the thickness of one rafter. This measurement must be divided into 6 spaces. Set out both sides of the ridge with square lines and tick against them on the sides on which rafters are to be placed. The total number of rafters required is noted for cutting from the pattern. A gauge line is marked 3" from the top of the ridge for rafter tops.

USING THE PATTERN RAFTER.

Cut the pattern accurately on its set out lines, and attach fences to its top edge, as shown in Fig.6.

The top edge must be used for gauging across the width as well as the length, so that all rafters will make one uniform height over the walls.

The fences are short and are used during the marking operation to guard against any movement of the timber.

Allow length for, but do not mark, the bottom plumb cut; it will be marked from a line, after erection.

The number of rafters to be marked and cut will be ascertained from the set out on the ridge.

When placing the rafter under the pattern, make any round length go against the fence.

The best pieces of timber available for rafters are selected for overhanging gable ends.

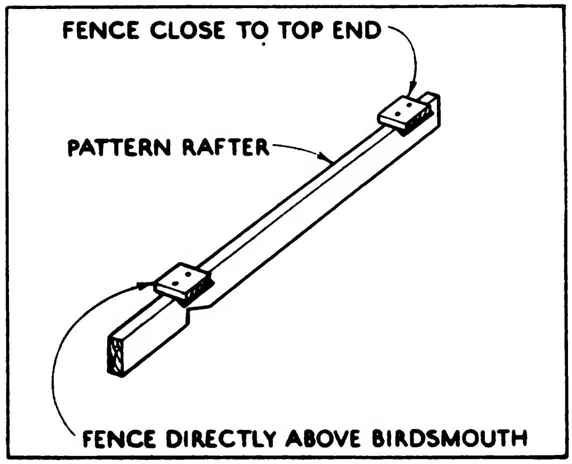


Fig.6 Fences on Pattern Rafter.

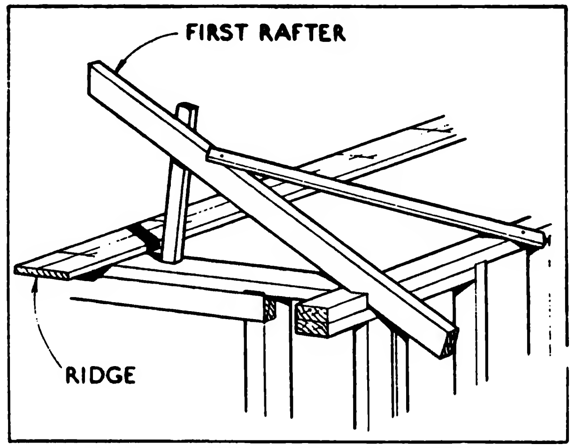


Fig.7 Erecting the first Rafter.

ERECTING THE GABLE ROOF.

A scaffold platform will be necessary over the middle of the building, to allow the roofer to move from end to end. The ridge must be laid on the platform so that it can be picked up easily when required.

Rafters are erected in pairs, the two pieces directly opposite each other across the span forming a pair. The first rafter erected is one immediately over the end wall, as shown in Fig.7. Prop up one rafter to its approximate pitch, and skew nail it to the top plate at its birdsmouth cut. Brace the head into the upright line of the wall under it.

Erect the partner rafter in the pair from the other side of the building, but before it goes up drive a 3" nail into the head, far enough to have the point projecting slightly, through its plumb cut. This will assist in keeping the second rafter in position while its birdsmouth is being nailed to the top plate. The same procedure is followed at the other end of the building, thus creating two pairs in temporary positions.

Erect the ridge by lifting it, edge first, to slip up between first one pair of plumb cuts, and then the other. Only when both ends are up can any rafter brace be loosened and the positions of the rafters corrected before finally nailing them to the ridge.

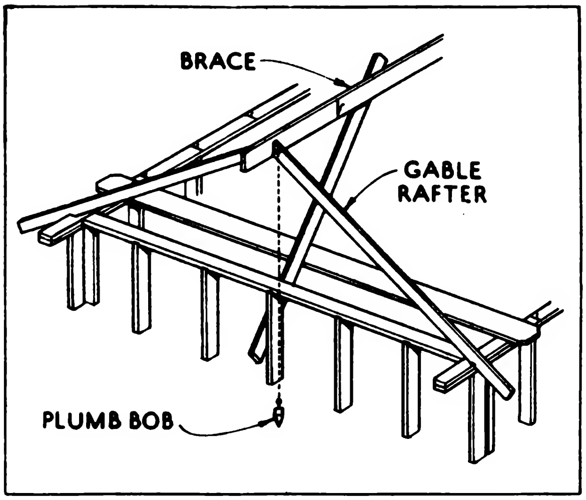


Fig.8 Plumbing the first pair of Rafters.

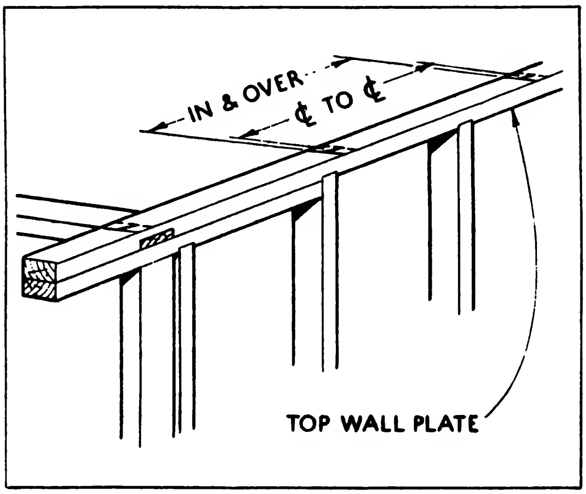


Fig.9 Spacing the Rafters.

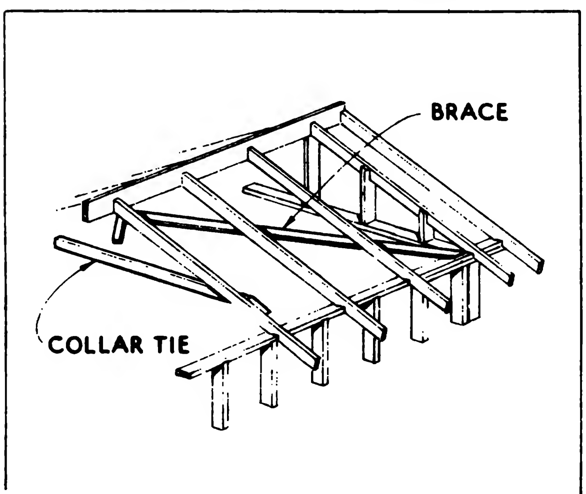


Fig.10 Bracing the Roof.

Check the uprightness of the head of the front pair of rafters, using a suspended plumb bob, as shown in Fig.8, then brace from the inside of one long wall, placing the brace in such a position that it will not interfere with the fixing of any other rafter.

The spacing out of rafters along the ridge and top plates is done by setting out the first gable rafter, and measuring what is known as "in and over", i.e., the distance from the inside edge of one rafter to the outside edge of the next one as shown in Fig.9. This method of spacing allows any difference in the thickness of a rafter to show on one side of its position and does not require finding the centre for every piece.

The remaining rafters are fixed with the spacing along the wall plate agreeing with that already set out on the ridge.

BRACING THE ROOF.

Braces, 3" x 1", are cut to run diagonally across each side of the roof, and are nailed to the under sides of the rafters, as shown in Fig. 10. The first brace commences with a bevelled cut on the top of the wall plate and finishes with a mitre cut on the under side of the middle rafter. The second brace comes from the other end of the wall plate and meets the first brace in the mitre cut on the middle rafter.

Collar ties are commonly applied to each second pair of rafters. The height they are fixed depends on the length of the rafter and the proximity of the other cross-tying members. In a small roof, a suitable height is one third of the distance between the plate and the ridge. The lower the tie is fixed, the greater is its efficiency.

GABLE STUDS.

Short studs are fixed between the top plate of the wall and the gable rafters, as shown in Fig. 11. The studs make a square butt joint on the top plate and are nailed at the normal stud spacing.

The middle stud is also square cut, and nailed to the ridge. Other studs must be cut to go around the rafters, and are fixed to finish with their edges flush with the face of the rafter.

CORNER BRACES.

Braces, 3" x 1", are nailed to the top plates (at an angle of approximately 45 degrees) with one end directly above the door frame post and the other end on the outside wall, as shown in Fig. 12.

These brace the corners together and assist in keeping the posts from moving out of line when heavy doors are swinging open.

CUTTING THE RAFTER FEET.

This operation is deferred until the wall sheeting is being fixed and a scaffold is available.

The plumb cuts are tested for position before being finally cut. The test along the row is made by stretching a chalk line from end to end at a height clear above the rafters, and either a bevel or a spirit level is used to test the plumb cut across each rafter, as shown in Fig. 13. A line marked from a bevel depends on the top of the rafter being straight.

The end to end line may be marked on the row of rafters by "snapping" a line previously rubbed with chalk. This line should be of fine gauge and the "snap" must strike vertically on to the rafters. A handy tool to use for the plumb line is the combination square and level.

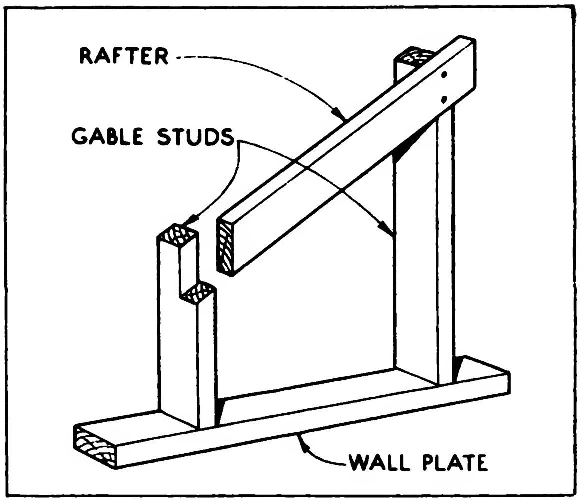


Fig.11 The Gable Studs.

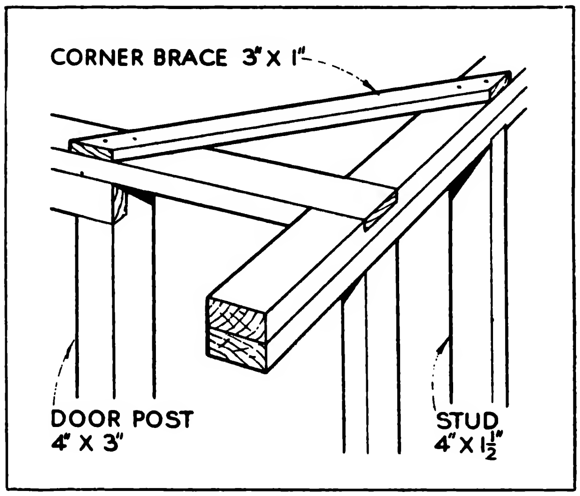


Fig.12 Re-marking Plumb Cuts on Rafter Feet.

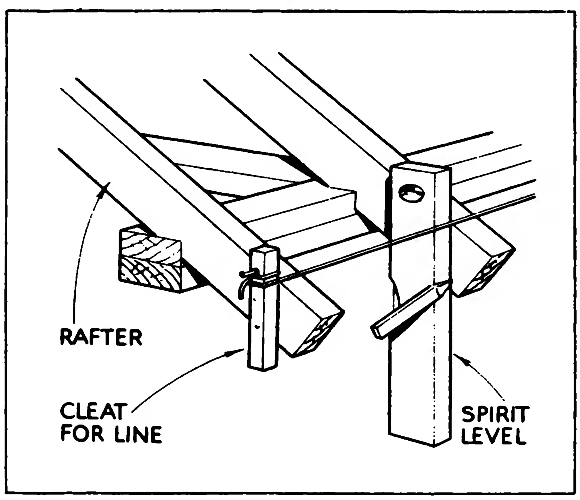


Fig.13 Testing Plumb Cuts for Rafter Feet.

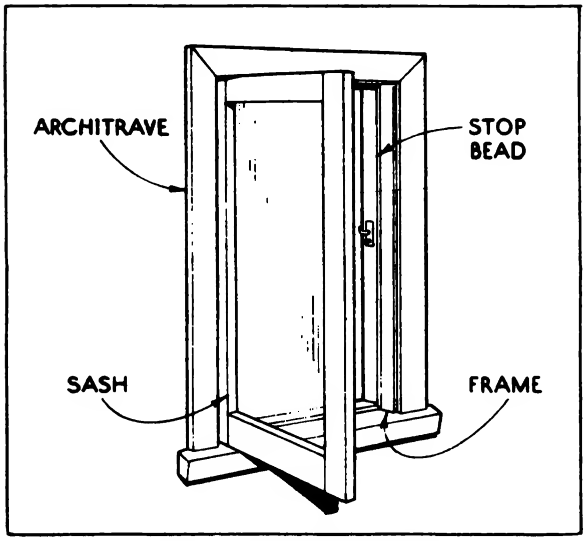


Fig.1 Casement Window.

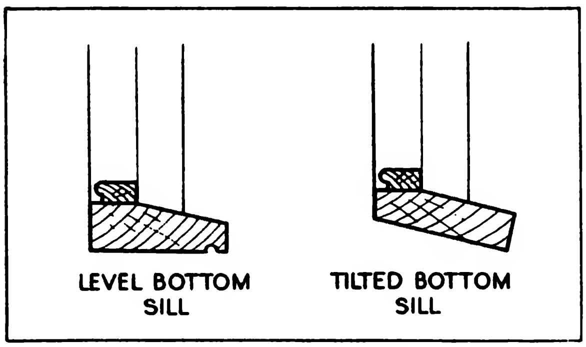


Fig.2 Types of Sills.

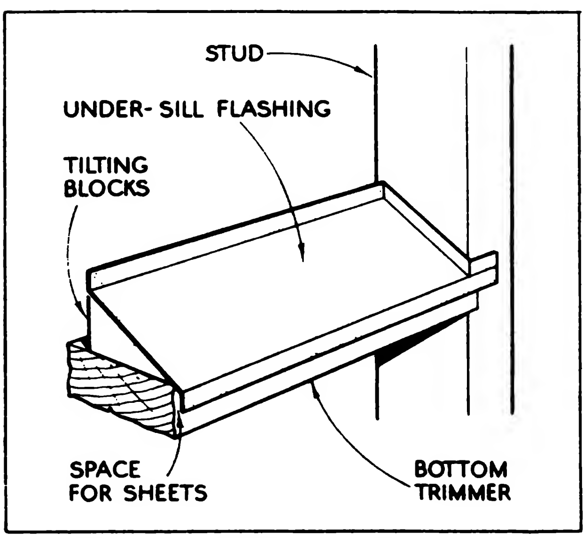


Fig.3 G.I.Flashing for under the Sill.

CASEMENT WINDOWS.

The specification of the casement window is as follows:-

Frame:

Stiles & Head.	$3\frac{3}{8}$" x $\frac{7}{8}$"	Hardwood
Sill.	5" x 2"	Jarrah
Staff Beads.	$1\frac{5}{8}$" x $\frac{5}{8}$"	Hardwood

Sashes:

Stiles & Top Rail.	$2\frac{1}{3}$" x $1\frac{3}{8}$"	Red Pine
Bottom Rail.	$3\frac{1}{4}$" x $1\frac{3}{8}$"	Red Pine

Casement windows are made of solid frames with sashes. The sashes are fastened in the frame or hung on butt hinges. They usually open outwards, as shown in Fig. 1. To hold a sash in open or closed position, a special fitting, known as "Combined Stay and Fastener" is used.

Sash frames are made to size and supplied by the joinery mills ready to be built into the walls. The sill of the frame may be flat bottomed or tilted, as shown in Fig. 2.

SEATING THE CASEMENT FRAMES.

Level bottom sills rest on the trimmer provided in the wall frame. When the sill is tilted, the trimmer may be tilted or flat. The latter requires wedge shaped blocks spaced out and nailed across it. These wedges allow making any necessary adjustment over the trimmer when levelling the length of the window sill.

To prevent any rain water which might filter through the bottom of the window frame from travelling inwards, a tray of galvanized iron under flashing is made It covers the supporting timber of the window sill, as shown in Fig. 3. The iron is turned up around the inner edge and ends of the sill, and is wide enough to turn downwards over the outside sheeting.

LENGTH OF THE WINDOW SILL.

The overall length of the projecting window sills in timber walls must be longer than the opening between the studs of the wall frame. The extra length is to give a stop for the architraves that surround the frame. The size of these architraves must be studied before cutting off the sill. The same size margin should project past the architrave at an end and front of the sill, as shown in Fig.4. The head of a window frame is cut as long as possible to give a sliding fit between studs.

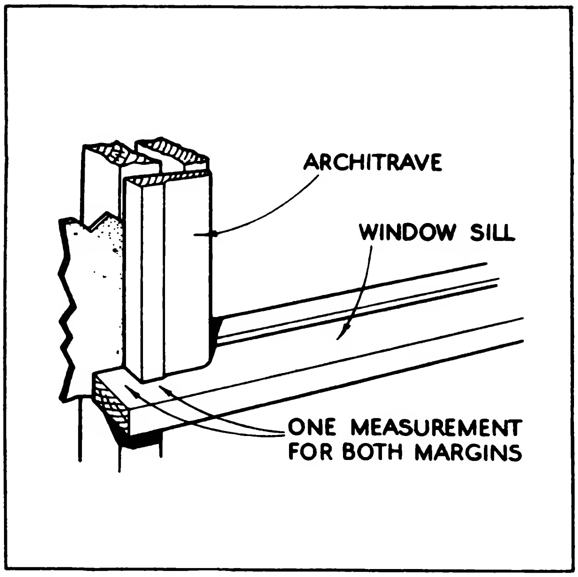


Fig.4 Determining the Length of the Sill.

FIXING THE CASEMENT FRAME.

The usual method of fixing the casement frames is by nailing through their stiles on to the wall studs alongside them, as shown in Fig.5. The overall width of window frames is slightly smaller than openings between the studs. This gives the opportunity to square up the frames with packing cleats that are cut exactly to size and secured with nails driven through the frames and going into the studs. Test the length of the sills, and also the faces and edges of the stiles, with a spirit level, before nailing into final positions.

In order to avoid the risk of breaking the glass, the sashes are not usually hung in the frames until the later stages of building work.

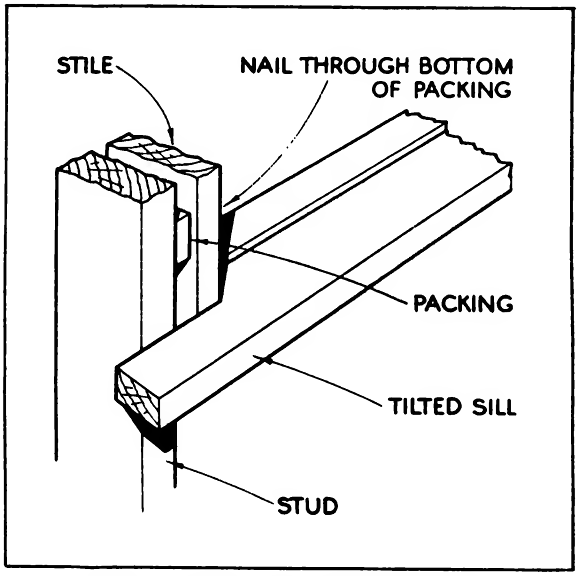


Fig.5 Fixing the Casement Frame.

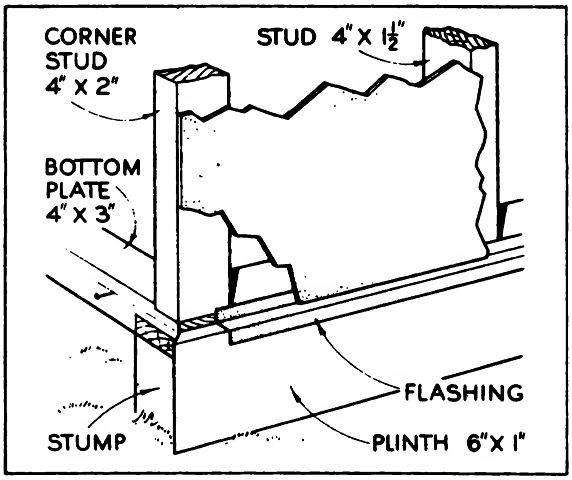


Fig.1 Plinth mitred at Angle.

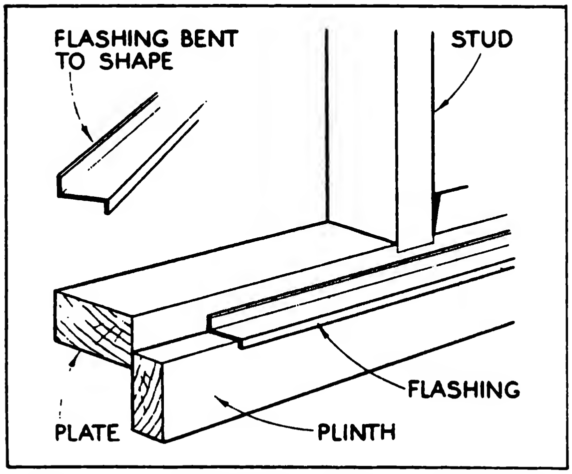


Fig.2 G.I.Flashing to protect Bottom Plates.

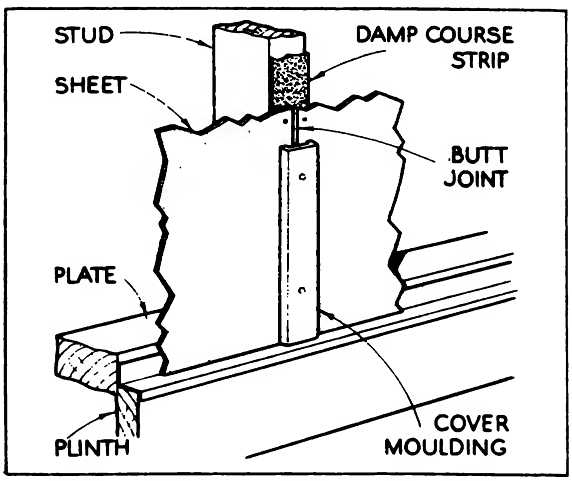


Fig.3 Fixing A.C. Sheets to the Studs.

THE PLINTH.

The base member of the exterior wall covering is the plinth, which must be carefully levelled because it forms the base line for the sheeting or other materials which rest on it. The top edge should be levelled by means of a spirit level.

The height of the top edge is indicated on the set out and at suitable points along the bottom plate, nails are part driven to form fixing gauges, as shown in Fig. 1.

The corner joints are mitred so that no end grain will show on the finished work.

FLASHING.

Galvanized iron flashing is necessary to protect the bottom plates from rain water, and is made to fit against the plate and over the plinth, being nailed to the plate, as shown in Fig. 2. Flashing of the same type, but slightly different in size, is placed over the head of the door frame.

Flashing must also be attached on the trimmer above the window opening, and left with enough projection to turn down on the face of the architrave. The height of this flashing must be measured from the sill of the window frame to the top of the architrave.

ASBESTOS CEMENT SHEETING.

Each stud where a sheeting joint will occur must have a damp proof strip nailed on it, as shown in Fig. 3.

The standard width of asbestos cement is 3 ft. or 4 ft., and length varies from 3 feet to 10 feet. Sheets of 11 feet and 12 feet are also made when required.

FIXING THE SHEETING.

The operation of fixing involves testing the sheets for size, cutting where necessary, and nailing in position. No preparation of the sheets is required before fixing them on wall framing which is set out to standard sizes. Narrow widths are cut by manufacturers at extra cost. A special hand tool is made for cutting sheets on the job, or they may be scored with a file tang or saw and snapped off along the line.

Special galvanized flat headed nails with blunt points are used for fixing the sheets. Shear cut blunt points drive their way through the thickness of the sheets, taking a small part of the sheet before them. Sharp pointed nails spread surrounding material away from them, and when used near the edge of a sheet, chip away part of the edge instead of fastening it. On all asbestos cement work a nail must be driven only so far that the under side of its head holds the sheet. If the head is driven flush with the sheeting it often breaks through the whole thickness of the sheet.

A scaffold is used when fixing high sheets, and while it is available, the rafter feet are cut back as previously described.

SHEETING THE GABLE ENDS.

The triangular shapes on the gable ends between the top plates and the under side of the roofing are covered with sheeting specially cut to shape. The setting out of these shapes requires careful planning on account of asbestos cement sheets having one face side only.

If a vertical joint is necessary in the middle of the gable end and a sheet is cut as shown in Fig.4, the piece marked "A" can be used to cover the part where it stands to the left of the centre line. The other piece, marked "B", cannot be used for the right hand area of the same end. It fits the left hand area of the other end. The pieces for the right areas of both ends are cut in the same way from another sheet.

When the rise of the roof is not more than 4 ft. - the width of a standard sheet - and the span is not more than the greatest length of sheeting available, two gable end shapes may be cut from the one sheet, as shown in Fig.5. The piece "A" will cover one end, and the pieces "B" and "C" will cover the second end.

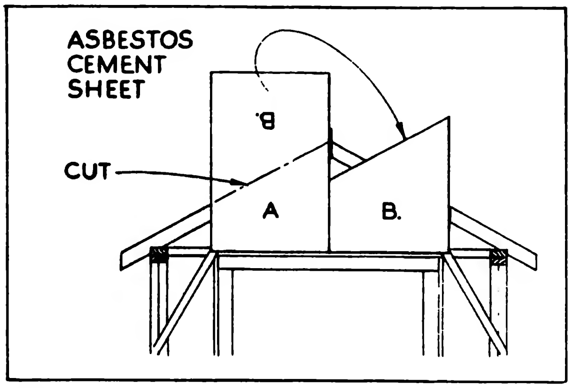


Fig.4 Cutting A.C. Sheets for the Gable Ends.

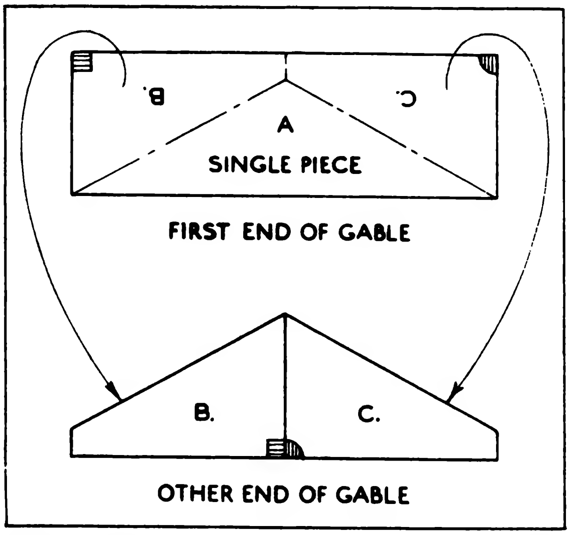


Fig.5 Alternative Method of Cutting the Sheets

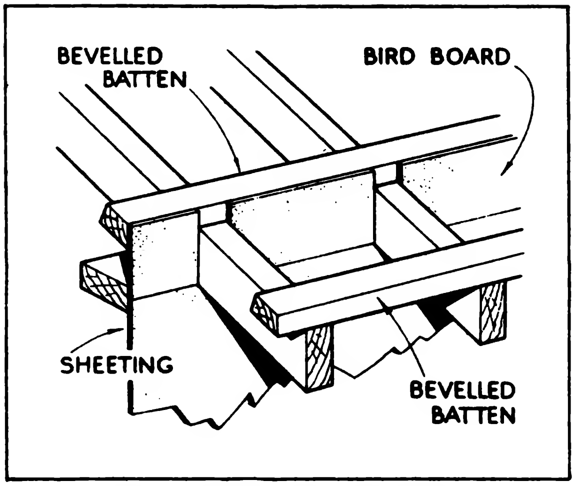


Fig.6 Fixing the Bird Board.

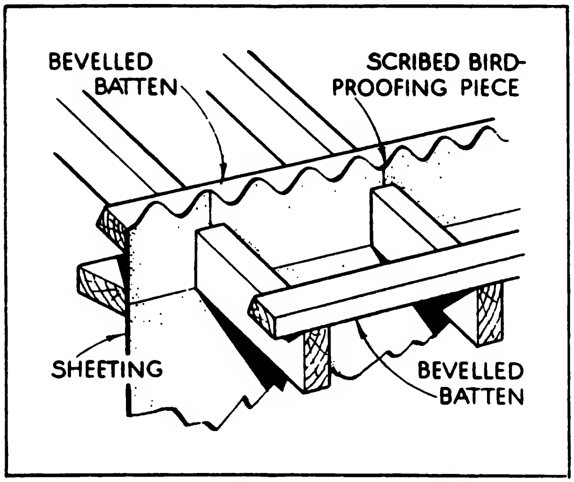


Fig.7 Scribed Bird Proof Sheeting.

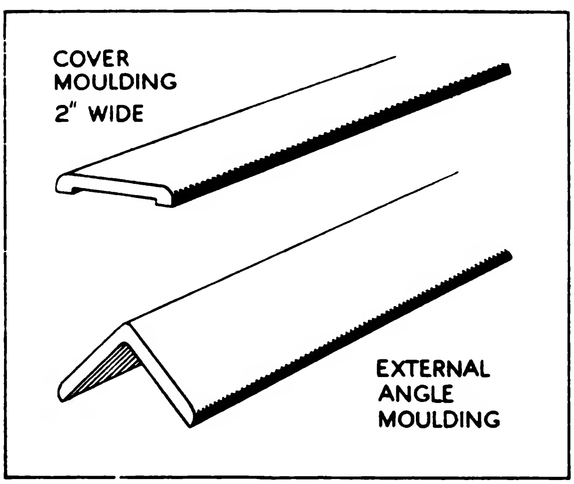


Fig.8 Cover Moulding Strips.

BIRD PROOFING.

The space on the long walls between the rafters and the roof sheeting is covered by a piece of sheeting, as illustrated in Fig.6. This covering is known as a bird board.

Before the bird board can be fitted, a bevelled batten is nailed on the rafters directly above the wall plate.

The bird board is then nailed to the batten and to the wall plate in the spaces between the rafters.

For roofing which has large corrugations, sheeting pieces already moulded to fit into the corrugations, are obtainable from asbestos cement manufacturers.

The widths of these sheets are various, and the top edges are as illustrated in Fig.7.

COVER MOULDING.

Cover moulding strips, as illustrated in Fig.8, are specially made for fixing over joints.

Cover moulding strips are nailed in position with blunt galvanized clout tacks, $1\frac{1}{4}$" in length.

Flat moulding is used to cover edge joints which butt together.

Special angle moulding covers the corner joints.

Should moulding be required on a job with an internal angle, another special shape of cover moulding is available.

MEASURING FOR THE CASEMENT SASH.

A casement sash is often difficult to fit into its frame as the finished position is in the middle of the frame up a sloping sill. The height of the sash is measured inside the frame by means of a rod extended with a rule measurement from a line marked on the rod, as shown in Fig. 1A, or the necessary point may be levelled across the face of the frame to its outer edge by means of a try square, as shown in Fig. 1B. Always measure the greater length.

The bottom of the sash must be made to fit the slope of the sill. A bevel is set to the angle of the slope, as shown in Fig. 2A, and is applied to the sash with the longer length of the sash on the outside face, as shown in Fig. 2B. Test the height and width of the sash with those of the frame, and see that both are square before commencing to cut the sash.

See that the puttied glass of the sash faces outside to the weather and that the moulded edge faces inside.

FITTING THE CASEMENT SASH.

Fit the hinge edge of the sash to the frame and from that edge square the top of the sash. The locking stile should be parallel with the hinge stile. Lay the sash flat on stools with the glass side up and gauge its width, then plane off any waste. A hinged sash is cut at least $\frac{1}{3}$" smaller in width and height than the opening in the frame. The locking edge is bevelled inwards to allow a clear passage for the thickness of the sash when it rotates around the centre of the hinge, as shown in Fig. 3. A narrow sash requires bevelling more than a wider one because of the short radius of movement.

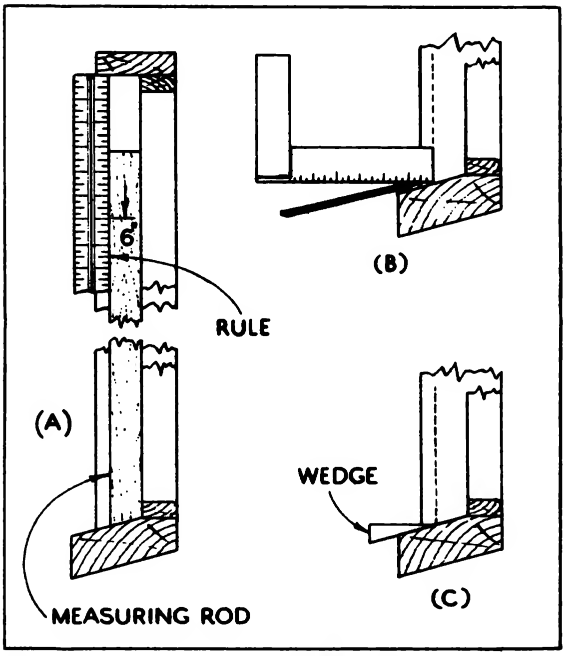


Fig.1 Measuring the Length of Casement Sash.

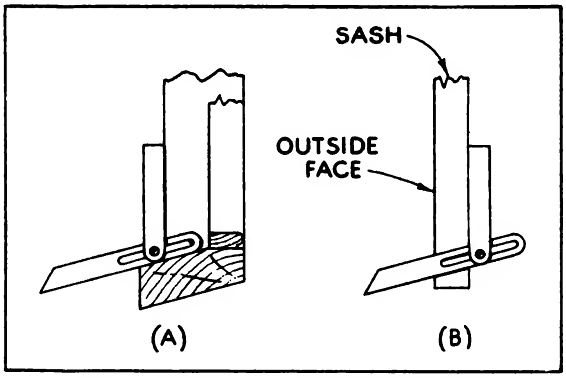


Fig.2 Bottom Bevel of Casement Sash.

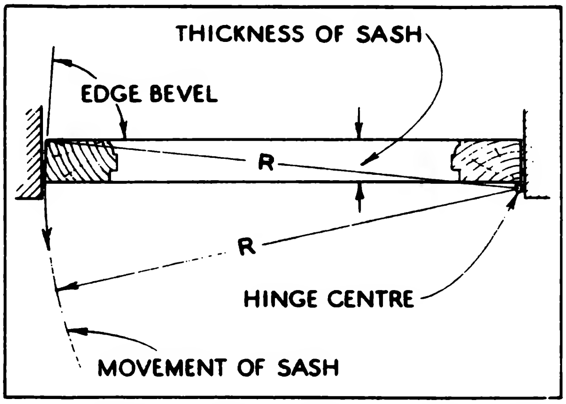


Fig.3 Bevel on Closing Edge of Casement Sash.

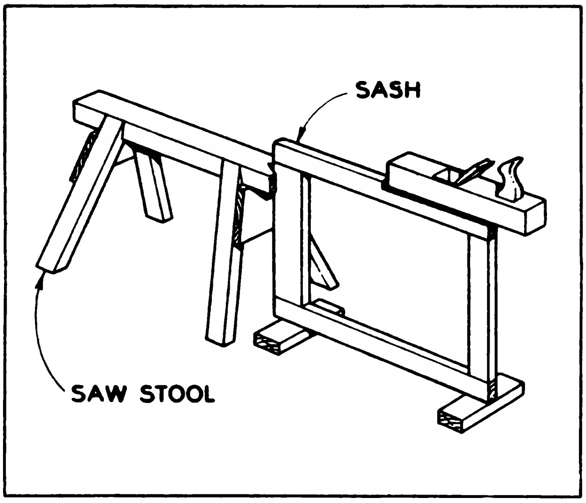


Fig.4 Holding the Glazed Sash.

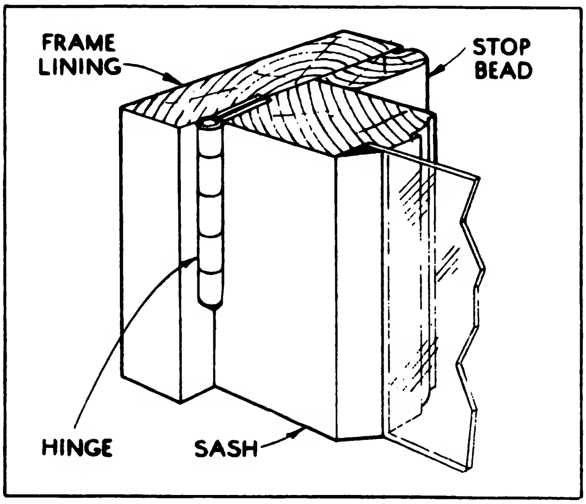


Fig.5 The Hinge in Position.

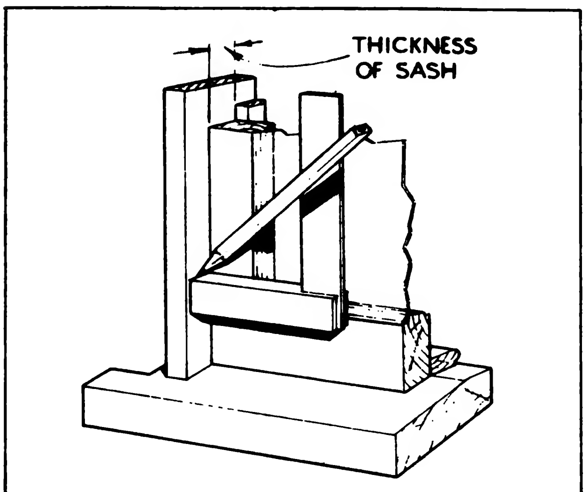


Fig.6 Marking the Position of the Hinge.

HOLDING THE GLAZED SASH.

Whenever a sash is laid flat, be careful to keep the glass side up especially when cutting, as new putty is easily displaced by vibration and glass will break unless it is well supported.

When no bench is available, some assistance is gained during planing by holding the sash on edge, and placing it in the Vee end of a saw stool top, as shown in Fig.4, provided that the other end of the stool top is placed against a rigid support. A point between the studs on an asbestos cement wall is not strong enough.

When trying the sash into the frame, a 2" nail partly driven into the stile will give a convenient finger grip for moving the sash in and out of the frame.

SETTING OUT HINGES ON CASEMENT SASH AND WINDOW FRAME.

Hinges on sashes and doors which are set inside the edges of their frames must have housings of unequal depths. These require careful cutting to make the knuckle of the hinge finish in the sash, as shown in Fig.5. If the correct housing is not made, a big joint will show between the frame and the hinged stile of the sash.

Pack up the sash in its correct position inside the frame, and with a pencil, mark the highest line of the top hinge and the lowest line of the bottom hinge on both the sash and the frame. Also mark the sash thickness in the frame.

The stock of a try square laid against the frame and the sash, as shown in Fig.6, provides a good base for marking lines on two sides of an interior angle.

Three gauge sizes are necessary for marking the set out of hinge housings, and are as follows:-

(a) The Depth Across the Sash. The marking point of the gauge is set to the thickness of the hinge, as shown in Fig. 7A. The point of the gauge is then applied to the back of the sash, as shown in Fig. 7B.

(b) The Width Through the Sash. The marking point of the gauge is set to the width of the hinge leaf, as shown in Fig. 8A, and the width marked on the edge of the sash by applying the gauge point as shown in Fig. 8B.

(c) The Width Through the Frame. The width of the hinge leaf is measured inside the pencil line which was made on the frame when the sash was held in the frame, as shown in Fig. 9A.

The length of the housings along both the sash and the frame is marked directly from the hinge, by placing it against the pencil lines already marked on them.

CUTTING OUT FOR THE HINGES.

The housings are first roughed out to barely the depth required, by using the chisel and cutting small pieces across the grain. The depth on the outside of the sash is to the set out line, but on the inside the depth is only to the thickness of the leaf of the hinge for which careful judgment must be used. Test the hinge in place before finally paring out the remainder of the wood across the grain.

When cutting the housings in the frame, commence between the sash line and the gauge line, and chisel cut across the grain. Then with a flat chisel, pare out from flush on the outside to the depth of the hinge leaf on the inside, as shown in Fig. 9B.

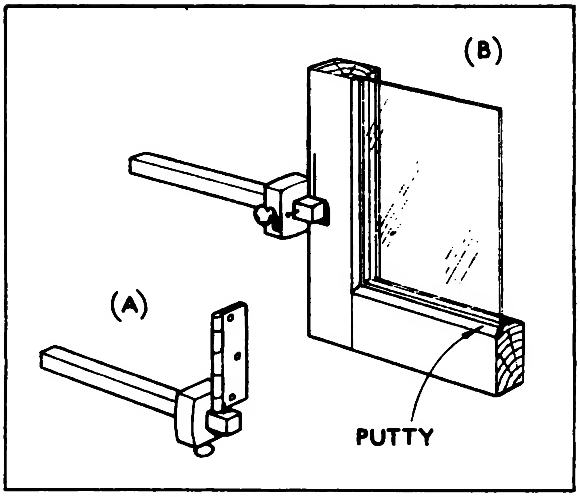


Fig.7 Gauging the Thickness of Hinge.

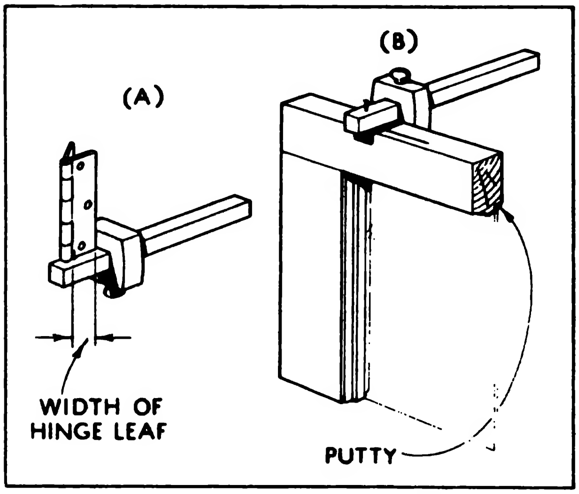


Fig.8 Gauging the Width of Hinge.

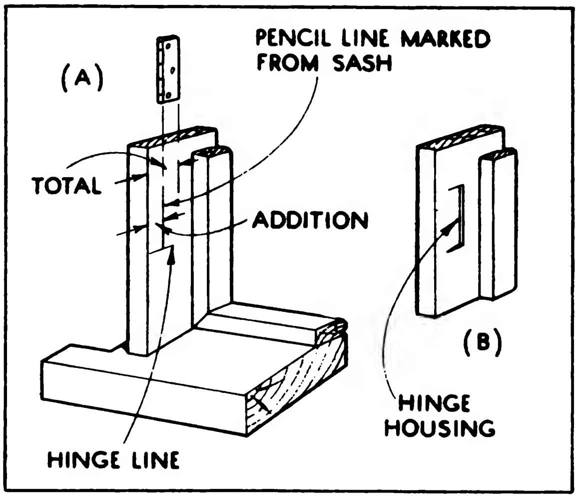


Fig.9 Setting Out Hinge on Frame.

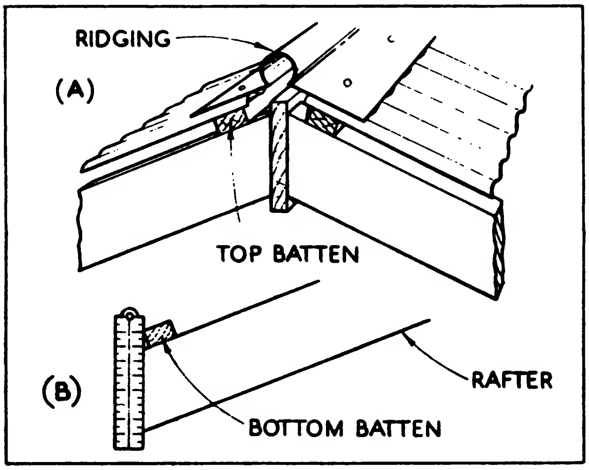


Fig.1 Position of Roof Battens.

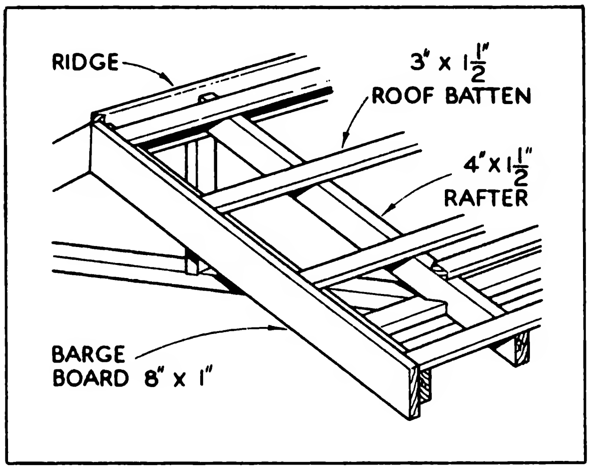


Fig.2 Position of Barge Board.

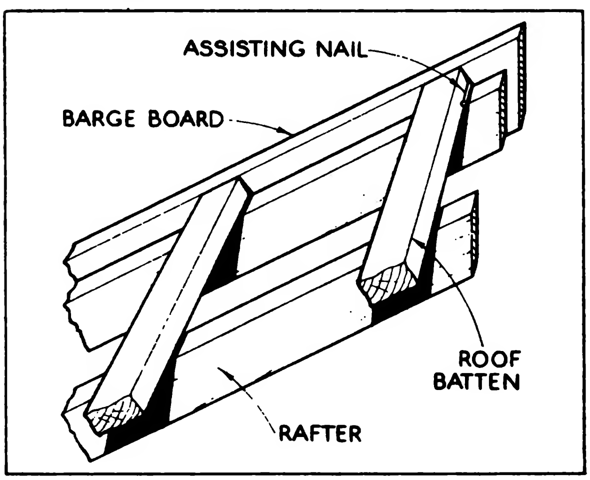


Fig.3 Hanging up Barge Board while Fixing.

ROOF BATTENS.

For corrugated iron or cement sheets, the standard maximum centre to centre spacing down the length of the rafter is 3 feet. Commencing near the ridge, one batten is placed so that the ridging can be nailed to it, as shown in Fig. 1A.

The bottom batten is lined up with the plumb cut of the rafter feet, as shown in Fig. 1B. The spouting brackets will be fixed by the plumber to the bottom batten by means of screws, and a bevelled batten will give better backing to the brackets than a square one.

When only one length of iron is sufficient and no overlapping lengths of sheets are required to cover the length of the top and bottom battens, intermediates are spaced equally between them. An 8' sheet requires 3 spaces with 2 intermediate battens. With overlapping lengths, the battens must be spaced to give nailing at the end of the top sheets.

The battens are of 1½" thickness, and are nailed with 3" nails.

BARGE BOARDS.

To give a finish to the end of a roof, barge boards are nailed to the outer rafters, as shown in Fig. 2. The top edge of a barge board will finish flush with the top of the roof battens. A good plumb cut joint is made at their junction on the ridge end. A plumb cut flush with the rafter foot completes the lower end. Part driven nails in the back of the barge board at the points of intersection between the rafter and the top and bottom battens, as shown in Fig. 3, will give some support to the weight of the barge board and prevent it from slipping during the operation of fitting and fixing.

ROOF PLUMBING.

At the stage of a job where walls are covered and the barge boards are fixed, the plumber attends to the spouting and the fixing of the corrugated iron and the ridging.

The stage for roof covering is dependent upon local weather conditions. When the roof is fixed before the walls are covered, there is always the risk of strong winds lifting the whole roof from its place, or seriously straining the timber frame.

The end of the spouting is made with mitred joints to form a shape known as "double returned", and is fixed to the barge board as shown in Fig.4.

A finishing roll on the edge of the corrugated iron covers the edge of the barge board, as illustrated in Fig.5.

A timber mould may be fixed under both the spouting and the roll if specified.

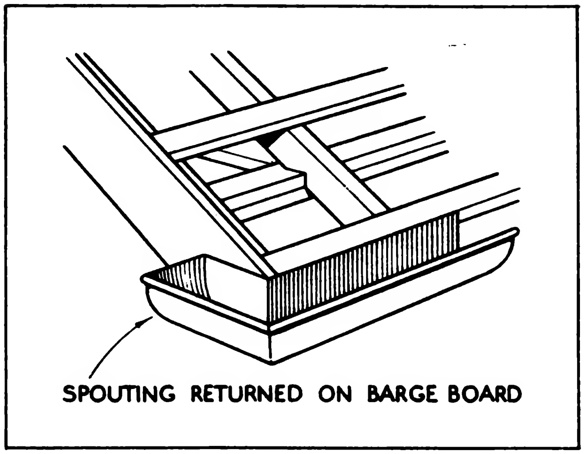


Fig.4 Double Return of Spouting.

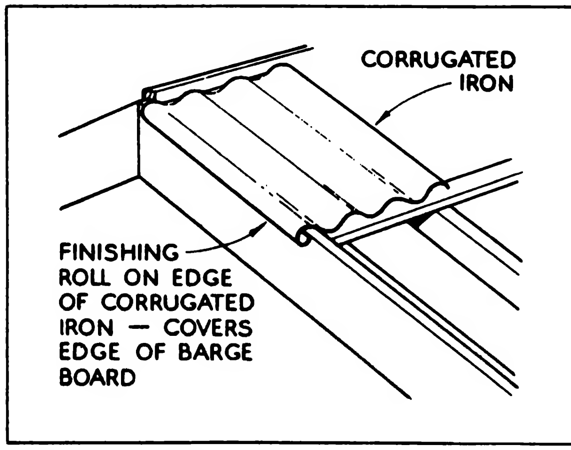


Fig.5 Corrugated G.I. rolled over Barge Board.

DESCRIPTION OF DOORS.

Garage doors are most commonly of the framed ledged type. The specification of the doors is as follows:-

One pair $1\frac{1}{2}$" framed ledged doors of selected oregon, sheeted with masonite or waterproof 3 ply. Closing stiles to meet with rebated and beaded joint.

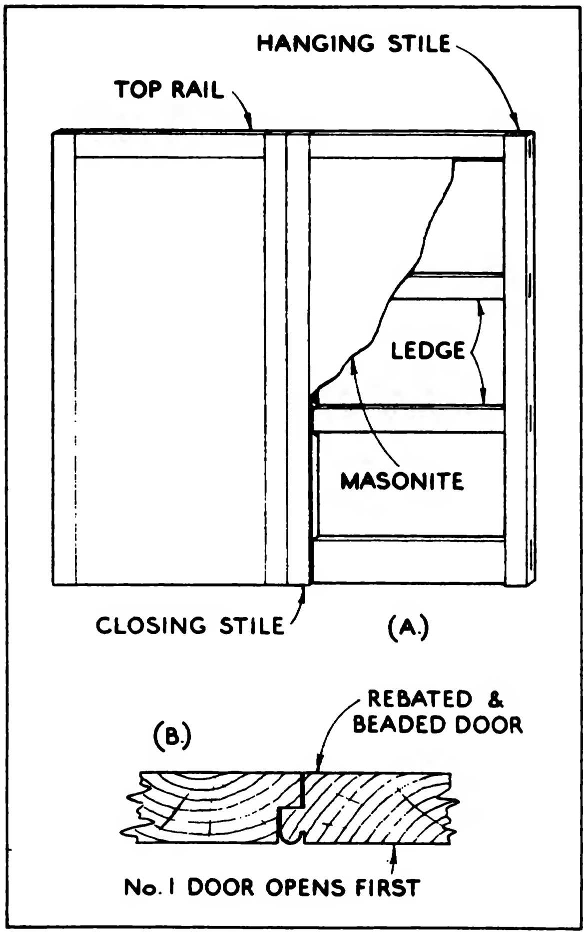


Fig.1 Framed Ledged Doors.

The doors will be made at the joiner's shop, and despatched ready for fitting. They are constructed of stiles and top rails of full thickness and have ledges which provide stiffening for the sheeting. These thinner level members do not show on the face of the door.

The stiles in a door are distinguished as either hanging or closing, as shown in Fig. 1A. In a pair of doors, the closing stiles meet in a rebated joint, in which part of one door overlaps the other.

When ordering from the joiner, it must be stated whether the right hand or the left hand door is required to open first. A single right hand door is one which has its closing stile on the right hand side when facing the door. In a pair, this right hand definition may cause misunderstanding unless clear instructions are given in the order. The most reliable method is to sketch on the order, the joint between the stiles, as shown in Fig. 1B.

FITTING A PAIR OF DOORS.

Doors should first be tested for size and shape to compare with the opening in the door frame.* Place the pair together as though in one piece, and with a measuring rod, take the overall sizes of width and height. The finished overall width of the doors should measure $\frac{1}{4}$" less than the width of the opening in the frame. Any waste overall width must be divided, and half the waste taken from each hanging stile.

Test the level of the door frame head, and if a fall to either side is apparent, mark clearly which is the higher.

First fit the door which needs the greater height under the head of the frame. Plane the waste width off the hanging stile, then erect the door in position against the outside of the frame. By means of chisels, wedges, or blocks of wood, make it stand directly against that part of the opening where it will finally hang, as shown in Fig. 2.

Allow a bare eighth of an inch clear opening between the door stile and the frame. Secure the door in place by tacking it through the horns of the stiles to the head of the frame.

The second door is now erected in its position, and is wedged up to the height necessary to make the rails across the two doors on one straight line. Taking the faces of the stiles and rail in the frame as guides, use the single thickness of a rule as a guide to scribe pencil lines on the door, as shown in Fig. 3.

The floor line cut must also be marked with a clearance of at least $\frac{1}{2}$" above the finished floor level.

Cut across the stiles with the panelsaw, and plane the outer edges of the stiles and rails to bring the doors to the size required.

In order to hold the doors in position whilst planing, a piece of notched scantling may be nailed in the door frame, as shown in Fig. 4. The nailing must be made inside the line of the doors so that disfiguring nail holes will later be covered by the door stop.

The success of the whole operation of hanging the pair of doors in this way is dependent upon accurate work, good hinges, and firm door frame. If one of these factors is not in order, one door must be hung first and the second one fitted between it and the frame.

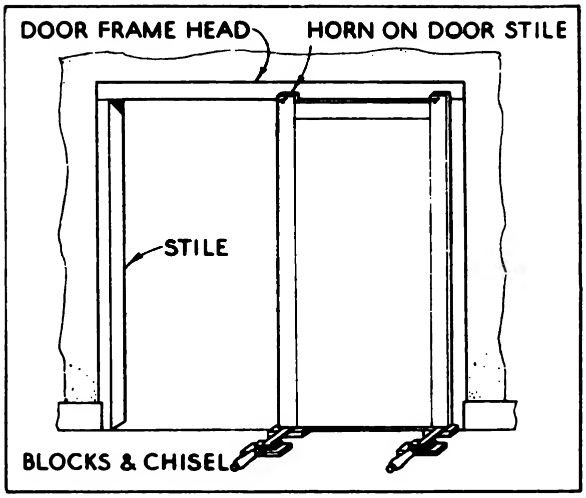


Fig.2 Holding the Door in Position.

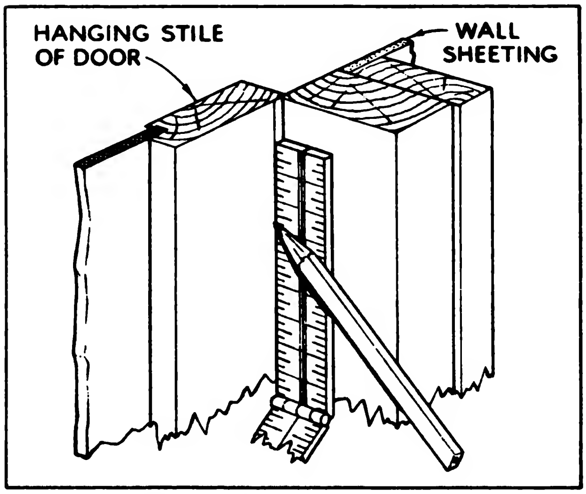


Fig.3 Scribing for the Width of the Doors.

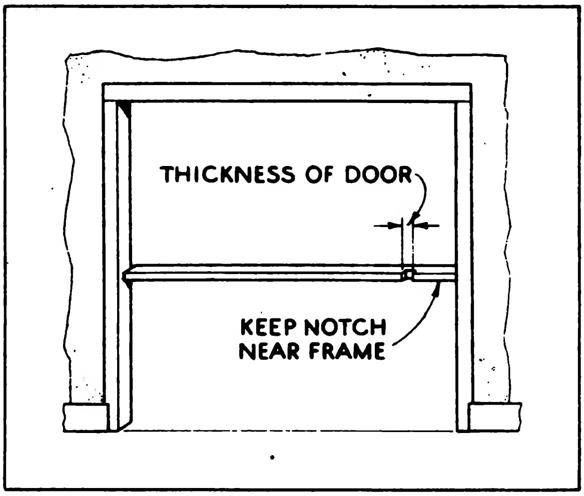


Fig.4 Scantling to hold Door whilst Planing.

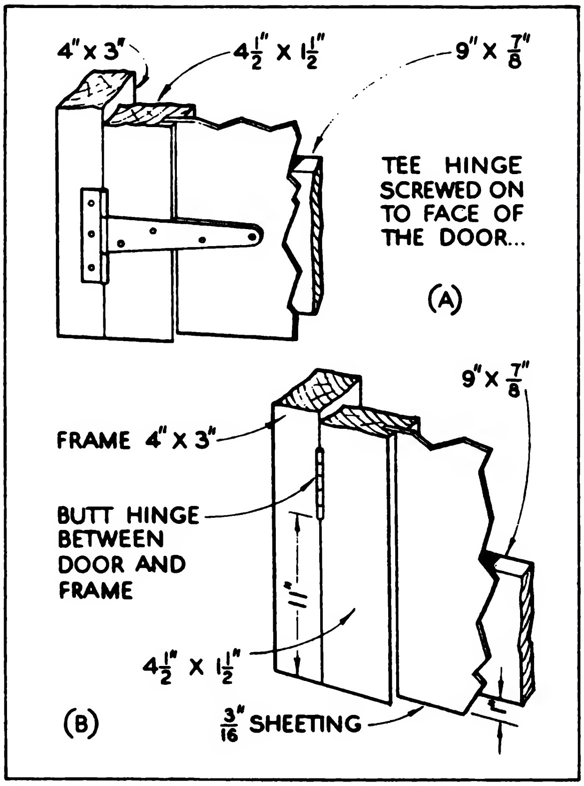


Fig.5 Tee and Butt Hinges.

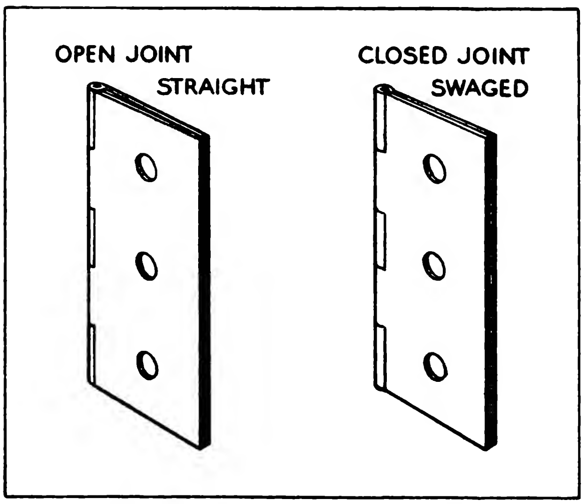


Fig.6 Two Types of Butt Hinges.

HANGING A PAIR OF DOORS.

The doors may be hung with Tee hinges, as shown in Fig.5A, or Butt hinges, as shown in Fig.5B. Tee hinges are more easily attached than butt hinges, but the latter give greater security and are neater in appearance.

Hook and Eye hinges are sometimes used for hinging a door and have advantages which will be shown in a later job.

Specification: Doors to hang on No.3 pairs of 4" steel butts.

The most important operation is the correct setting of depth gauges for hinges. Examine a butt hinge carefully when closed. Two types are shown in Fig.6. One has the leaves swaged further around the pin than the other, thus forming small or large spaces between the leaves. The depth of housing must be measured on the hinges before setting the gauge.

Set one gauge so that it will give equal depth of housing in doors and frame. Set another gauge to the width of the hinge leaf.

With the doors standing in position, mark the length of the hinge accurately on both the doors and the frame. Housings are cut in the doors, and when the hinges are placed in them, bore holes for the screws and then fix the hinges. If screws are driven without bored holes, they split the timber, wander in direction, and do not have full holding power.

Place the doors, with hinges attached, against the frame to see that the marks previously made on the frame correspond with the hinges. Housings are then cut in the door frame. Doors are now blocked or wedged in open position beside the frame. Screw holes through the hinges are first marked with a nail point or brad awl, then bored, and the hinges finally attached. As a slight adjustment may be necessary, try the door fit when a few screws are tightly driven into the hinges before making all secure.

FIXING THE LOCKS AND BOLTS.

The first door to be closed requires bolting when shut. Tower bolts or Barrel bolts are suitable when they are placed within easy reach. In a position above normal reach, Monkey-tail bolts or Chain bolts are more suitable. The second door is secured against the first door by a Hasp and Staple or Pad bolt. This is attached with coach bolts to give security against untoward removal.

Specification: Pair of doors to be fitted with No.2 11" Tower bolts, No.1 6" Pad bolt attached with screws and No.2 coach bolts.

Tower bolts are attached with screws to the top and bottom of the closing stile of the first door to be closed, (Fig.7). The top bolt must be secured with a staple or by a hole bored into the head of the door frame. The bottom bolt requires a block or other contrivance as a holder.

The Pad bolt is attached to the outside of the door that is closed last, as shown in Fig.8. The back plate will be prepared with square holes to take the necks of the coach bolt, thus preventing these from turning while the nuts are being screwed up from the inside.

FIXING THE DOOR STOPS.

Door stops make a buffer when shutting the door.

Specification: Screw to head of door frame, a stop 4" x $1\frac{1}{2}$" to each door, with grain running vertically. Nail stops 3" x $\frac{1}{2}$" to the door frame stiles.

The position of the door stops is measured with the doors closed and bolted. The top 4" x $1\frac{1}{2}$" short pieces are cut, bored, and screwed in position as shown in Fig.9. The side stops are nailed on the posts allowing a working clearance between their edges and the doors.

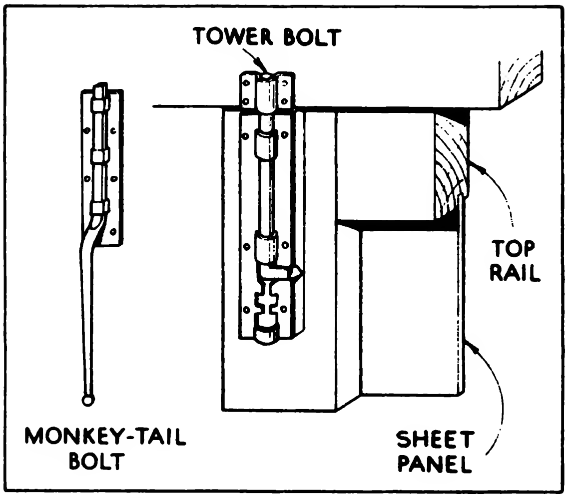


Fig.7 Two Types of Bolts.

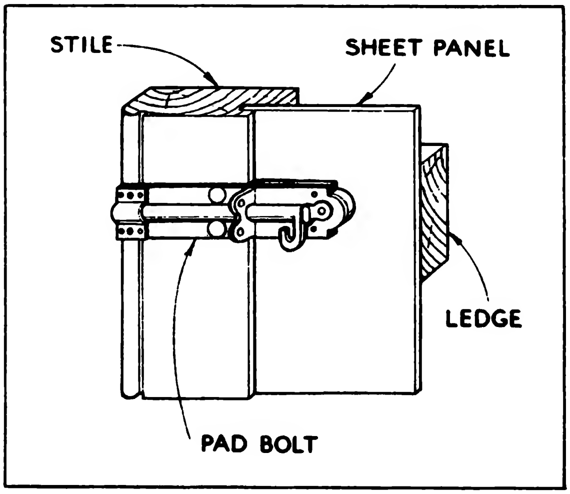


Fig.8 The Pad Bolt.

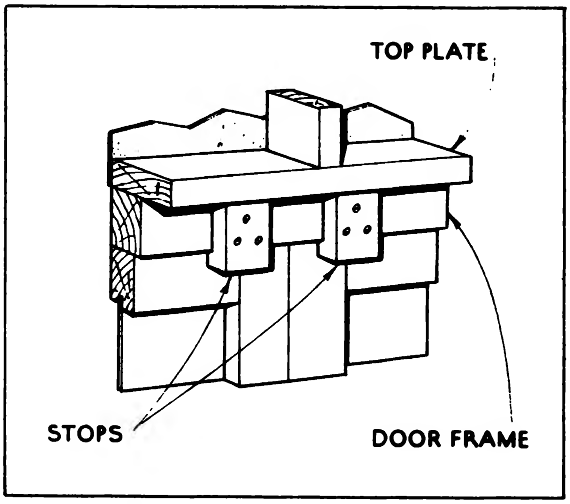


Fig.9 The Upper Door Stops.

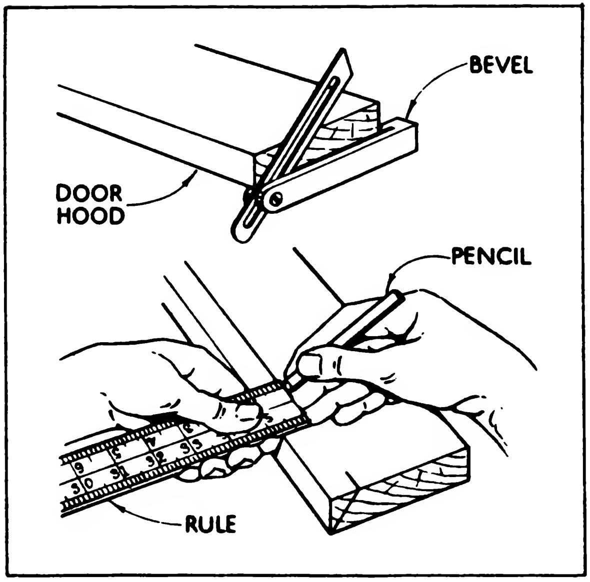


Fig.10 Applying the Bevel to the Door Hood.

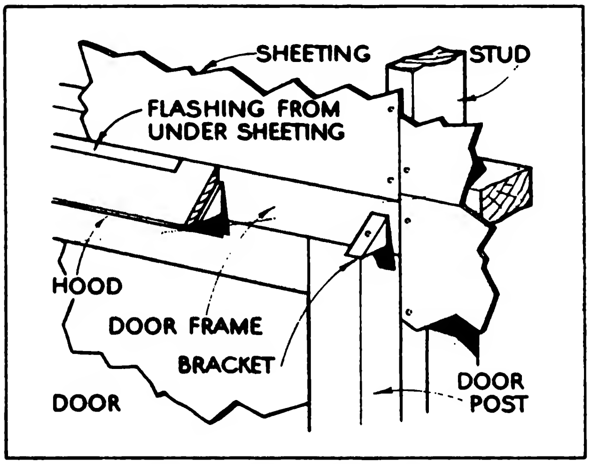


Fig.11 Fixing the Door Hood.

FIXING THE DOOR HOOD.

The door hood keeps the weather off the top of the door.

Specification: Fix on the head of the door frame, a 4" x 1" dressed weather hood. Support with $1\frac{1}{2}$" brackets at 1'6" centres.

Set the blade of a bevel to the correct angle, and mark this angle on both ends of the material, as shown in Fig. 10A. Along the length of the material, gauge a pencil line to show waste, as shown in Fig. 10B. Then with chisel and jack plane, cut the edge to shape. Test the shape and cut to the length required.

The bevel is again used to mark out the board from which the brackets will be cut.

Fix the brackets to the back of the hood and nail as one piece to the head of the frame, as shown in Fig. 11. Ensure that the line of the lower edge is clear of the top of the doors.

Metal flashing was left projecting over the door frame when the cement sheets were fixed. Now turn it down tightly on to the top of the hood. Cover strips are cut and fixed in positions above and alongside the door frame to finish off the sheeting.

ARCHITRAVES.

Architraves put the finishing touch to door and window openings. They cover the irregular spaces between the frames and the wall covering. Designs differ to suit various kinds of work. The dimensions are given in nominal sizes. Where work will be painted and the end grain of the uprights protected from the rain, square timber with butt joints may be used. Moulded architraves are generally used and these must be mitred as shown in Fig. 1.

A moulded architrave should be ordered in a length long enough to go all around an opening. This diminishes the risk of variation in size and pattern occuring at the joints. The head is cut from the middle of the length. Allow enough length to cover the waste on each joint.

Mitring the architrave around a window frame is done as follows:-

(a) Fit the two upright members to the sill and tack them on the frame, allowing $\frac{3}{16}$" of frame to show as a quirk.
(b) Mark them with the height of the head, as shown in Fig. 2, and scribe the line of right hand upright, as shown in Fig. 3.
(c) Take them down, cut left hand upright and the same end of the head.
(d) Fix left hand upright to the frame and make its joint with the head a good fit.
(e) Mark length of the head from that joint to the line on the right hand end of the frame.
(f) Cut, fit and nail to the frame, the right hand upright and the head.
(g) Single nails driven into the joints through the head should securely bind them and keep the faces flush.

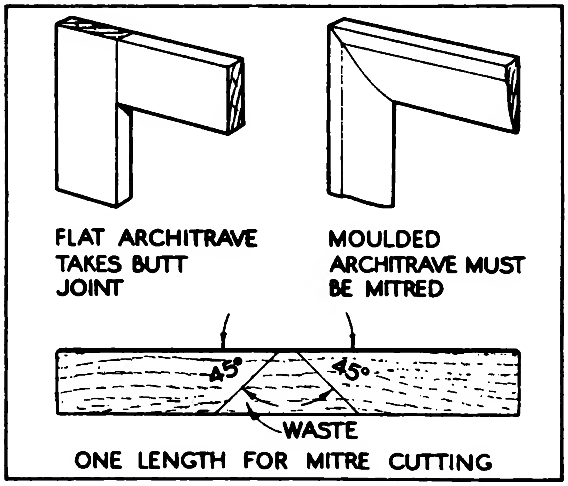


Fig.1 Cutting the Architrave.

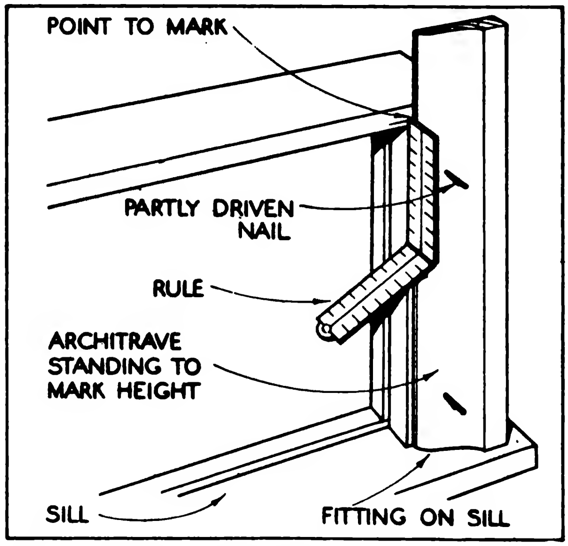


Fig.2 Marking Length of Vertical Architrave.

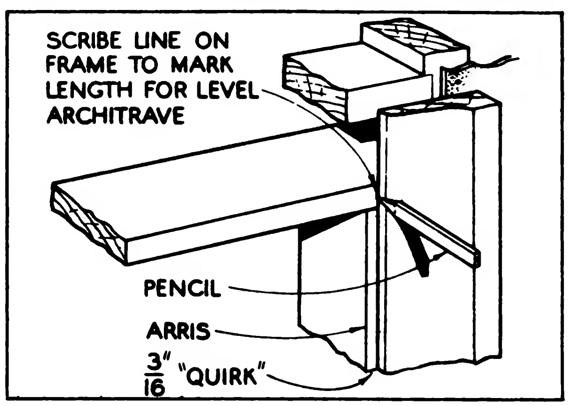
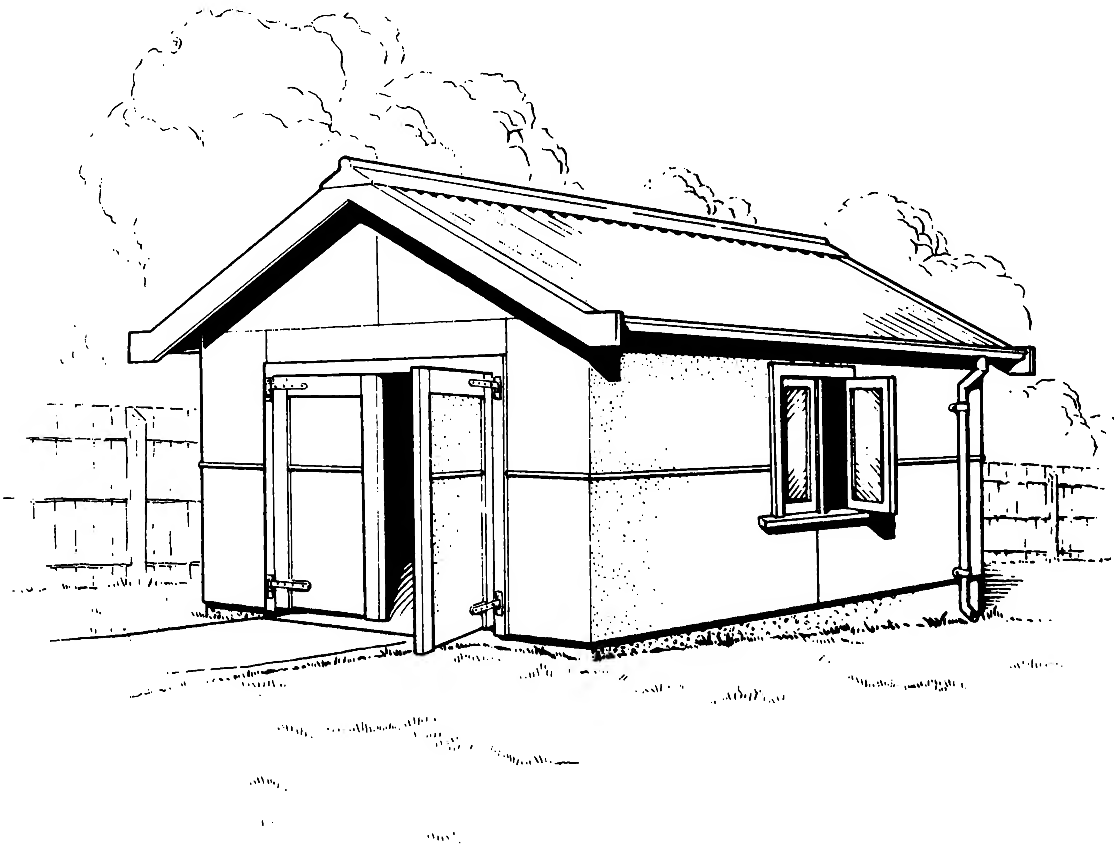
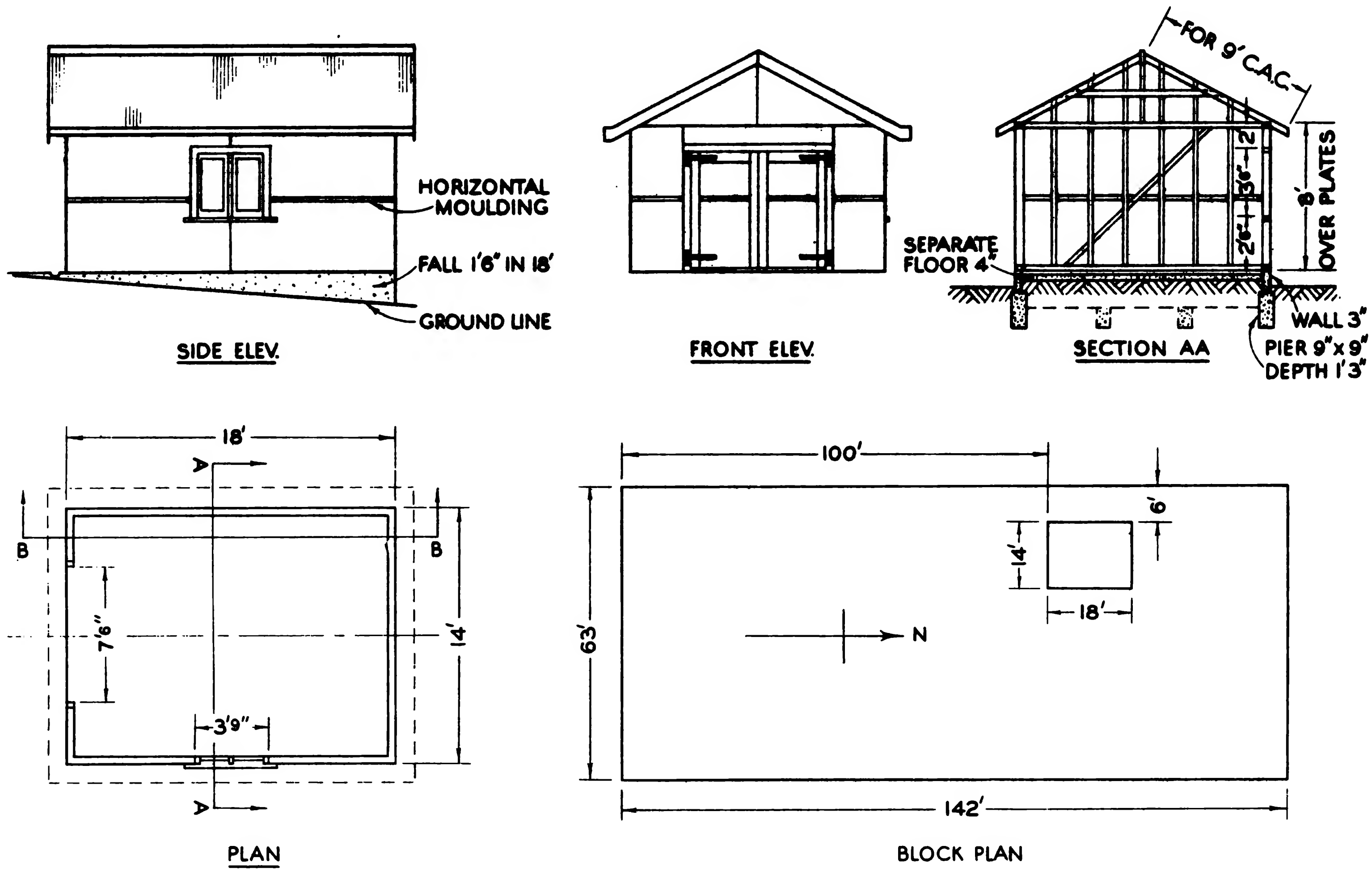


Fig.3 Scribing the Upright Line.



PICTORIAL VIEW OF GARAGE

TIMBER FRAMED GARAGE ON A CONCRETE FOUNDATION



GENERAL SPECIFICATION.

The garage is to be a detached, timber framed building, resting on a concrete foundation. The framed walls are sheeted with asbestos cement and the gable roof is covered with corrugated asbestos cement sheets.

SPECIFICATION OF MATERIALS.

FOUNDATION:

The concrete base will be in 3" reinforced concrete along the wall lines, supported by 9" x 9" concrete piers not more than 4' apart.

Proportions of concrete aggregates are - 1 part cement, $2\frac{1}{2}$ parts sand, and 4 parts metal. Reinforcement is of welded steel fabric.

The base will be cement rendered on the outside to bring its face flush with the timber frame.

TIMBER WALLS:

Bottom Plate	4" x 2"	jarrah on 3 ply bituminous damp course, and secured to concrete foundation with $\frac{3}{8}$" anchor bolts.
Top Plate	4" x 2"	hardwood.
Common Studs	4" x $1\frac{1}{2}$"	hardwood, not more than 2' centres.
Window, and Corner Studs	4" x 2"	hardwood.
Trimmers	4" x 2"	hardwood.
Braces	2" x 1"	hardwood.
Nogging Battens	3" x 1"	hardwood.
Packing Lath	$1\frac{1}{2}$" x $\frac{1}{4}$"	hardwood.

WALL SHEETING:

Asbestos cement $\frac{3}{16}$" thickness to cover walls and soffits. Wall sheets to be fixed horizontally.

Asbestos cement horizontal moulding to be used in all level joints between sheets, and metal damp proofing mould in vertical joints.

All to be fixed with galvanised shear point flat head nails.

ROOF:

Rafters	4" x $1\frac{1}{2}$"	hardwood, at not more than 3' centres.
Ridge	8" x 1"	hardwood.
Collar Ties	3" x 1"	hardwood, on all interior rafters.
Braces	3" x 1"	hardwood.
Battens	3" x $1\frac{1}{2}$"	hardwood.

Eaves gutters of asbestos cement 5" wide.
Rain head of asbestos cement.
Down pipe of asbestos cement 3".
Ridging of asbestos cement.
Roofing sheets of standard asbestos cement.
Barges of asbestos cement mould.

Drill all nail holes in asbestos cement and fix with drive screws, fitted with the special bituminous washers.

(NOTE: Other suitable types of timber may be specified.)

DOOR FRAME:

Posts	4" x 4"	jarrah, not less than 3' below ground level.
Soles) Struts)	4" x 2"	jarrah, two ways.
Head	6" x 2"	K.D.hardwood.
Stop	$2\frac{1}{2}$" x $\frac{1}{2}$"	K.D.hardwood to posts.
Stop	4" x $1\frac{1}{2}$"	K.D.hardwood to head in short buffers

All timber above ground level to be dressed.

All timber below ground level to be thoroughly brushed or sprayed with creosote oil.

DOORS:

Pair of framed doors, 7' x 7'6" x $1\frac{1}{2}$" oregon, panelled with masonite to detail.

Hang pair of doors on 12" hook and eye hinges secured with coach bolts.

WINDOW:

Dual casement frame, 4" x 2" oregon, rebated stiles, mullion and head.

Sill of 5" x 3" jarrah, weathered and grooved to detail.

Sashes of $1\frac{1}{2}$" K.D.hardwood, hinged on $2\frac{1}{2}$" butts and fitted with combined stay and fastener.

FEATURES IN THIS GARAGE WHICH DIFFER FROM THOSE IN PREVIOUS ONE.

Land is already fenced on its boundary lines.

Land surface is sloping downwards towards back of building.

Concrete foundation instead of timber blocks.

Bottom wall plate has thinner section and is secured to concrete with anchor bolts.

Asbestos cement sheeting with long edges placed horizontally.

Nogging battens in wall framing for fixing horizontal joint moulding.

Trimmer of opening in wall frame for window is placed on edge because of its long length.

Dual casement sash frame with flat sill.

Collar ties made of wider section material.

Plinth of timber is not required.

DESCRIPTION.

The completion of the garage requires a level floor of reinforced concrete to be laid inside the building, therefore the low parts of the earth must be filled in to a suitable height before the concrete is laid.

A reinforced concrete base for the wall has been selected to give durability and to act as a retaining wall for the earth filling of the floor. Concrete that is poured into a position which does not provide support for the mixture during setting, must have a mould built for it. Timber forms are commonly built for this purpose and are generally made in a manner which will allow their removal after the concrete has set. The foundation wall will require a timber form. The concrete will be poured so close to the door frame that its posts must be erected first.

The general outline of order of procedure in building will commence with the erection of the door frame and the formwork for foundation walls, and will then follow the same order of procedure as used in the erection of the previous garage. The roof is set out by the steel square method.

BOUNDARY LINES OF FENCED LAND.

The owners of adjoining blocks of land are joint owners of the fence. Fences in town areas usually consist of posts and rails framed together and covered on one side with palings, pickets, or wire fabric. In order to form a nominal centre line in the irregular thickness of a fence, the posts are placed on one side of the centre line, and the covering on the other side. The face of the posts thus becomes the nominal centre of thickness in the fence, and for the dividing line between adjoining properties.

LAYING OUT THE FOUNDATIONS.

Select the highest level of the ground on the foundation area for making the Building Line No. 1. Drive in it upright stakes at the required distance measured from the fence to the building line. Keep them far enough apart to be well clear of the foundation site. Stretch a chalk line between the stakes, and under it drive a peg at the first foundation corner. Drive in a reference peg at the 3' distance outside it, as shown in Fig. 1.

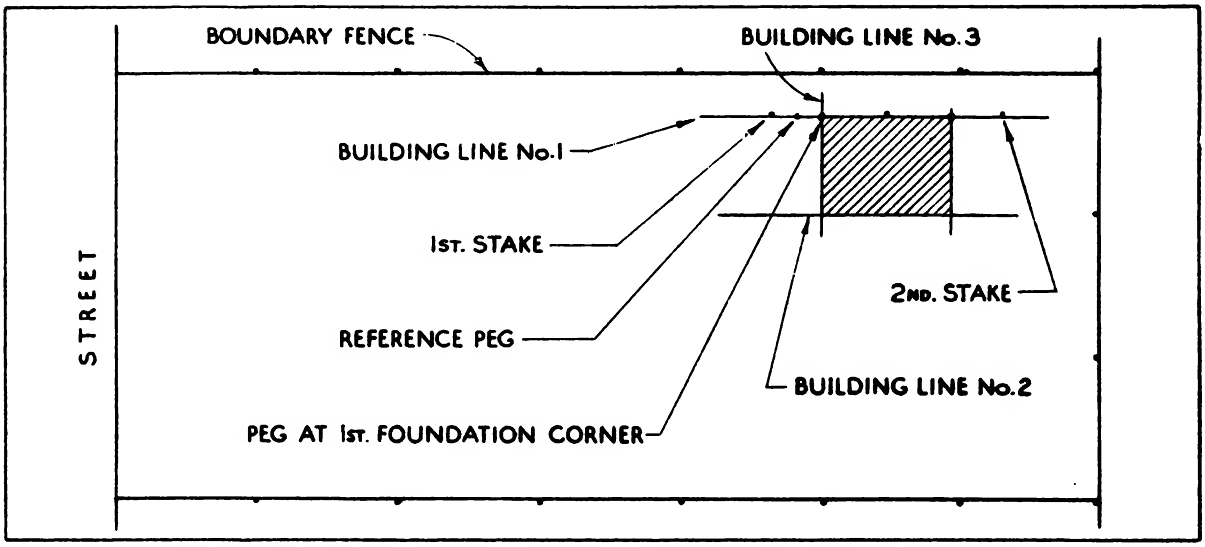


Fig.1 The Positions of the Stakes and Pegs in the First Building Line.

With the aid of the line level, make the staked line correct, and after marking on it the required length, plumb the marking point down to the ground.

Building Line No. 2 will now be established and made parallel to Building Line No. 1. Building Line No. 3 is next to be pegged square to No. 1 by the 6, 8, 10 measurements. All the measurements must be taken on level lines, as shown in Fig. 2. This applies to measuring a square corner as well as to a building length.

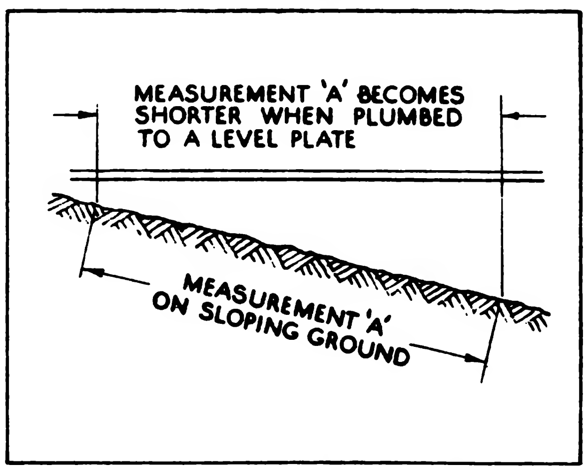


Fig.2 Measuring on a Sloping Site.

BATTER BOARDS

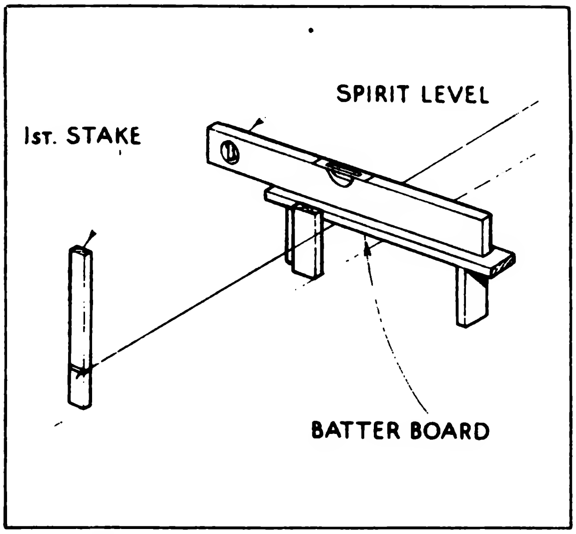


Fig.3 The Set-Up of a Batter Board.

Batter boards, commonly referred to as "hurdles", are used to indicate the positions and thickness of foundations and walls. They consist of a level batten supported by two stakes and are erected across the building lines. The top batten is long enough to have marked on it all the required measurements. The whole batter board must be rigid.

Erect a batter board at a height of approximately 6 inches above the ground and over Building Line No. 1, and with the aid of a spirit level, as shown in Fig. 3, make the top batten perfectly level along its length.

Alongside the top board make a "datum" level by driving in a stake with its edge against the building line. This level is extended over the wall lines and heights and depths will be taken from it as required.

LEVELLING A LINE WITH A SPIRIT LEVEL.

An alternative method of levelling the building lines is by the use of a spirit level and a straight edge, as shown in Fig. 4.

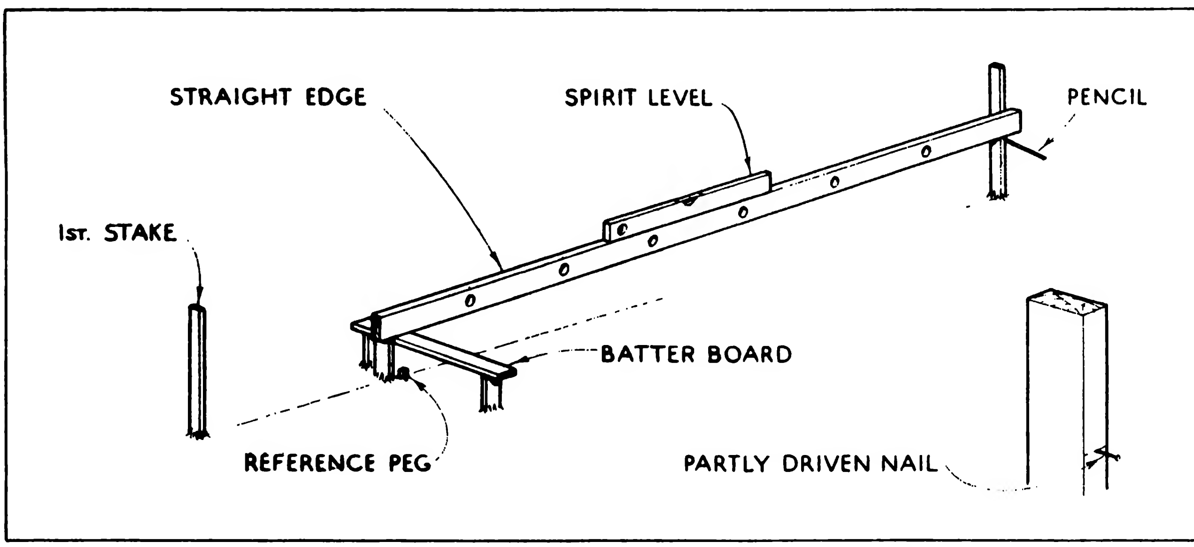


Fig.4 Levelling with a Straight Edge and Spirit Level.

The straight edge must be of good material, with a parallel width of approximately 4", and a length of not less than 10'. The operation of levelling is most successful when carried out with the co-operation of two persons.

At a distance from the batter board suited to the length of the straight edge, erect a stake alongside the building line with its top high enough to be levelled from the batter board.

Rest the straight edge on the batter board and hold the other end against the stake. The spirit level should be used in the middle of the length of the straight edge. By moving the straight edge up or down as required, a point is finally found on the stake which can be marked as exactly level with the height of the batter board. A partly driven nail is a useful method of marking this point.

The level will be extended to further stakes, by stretching a chalk line from the top of the batter board, past the stake, and making the height of the line register with the height marked on the stake, as shown in Fig.5.

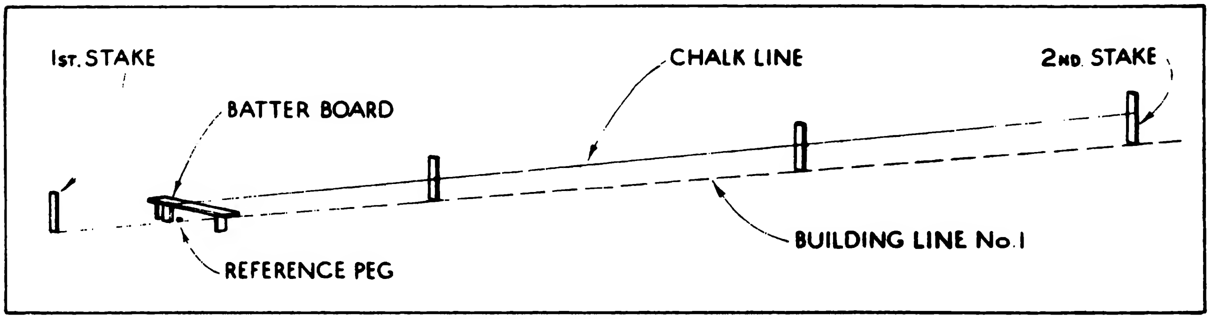


Fig.5 Extending the First Level with a Line.

Stakes will be driven at each corner at points that allow a clear working distance outside the foundation area, and on these stakes the datum level is marked.

Cross lines are levelled to their stakes by running them in contact with Level Lines No.1 and No.3, as shown in Fig.6, and a check is made of the accuracy of the measurements and diagonals before progressing further.

At the entrance door, a definite height of the finished floor level must now be decided, and its measurement from the datum height recorded.

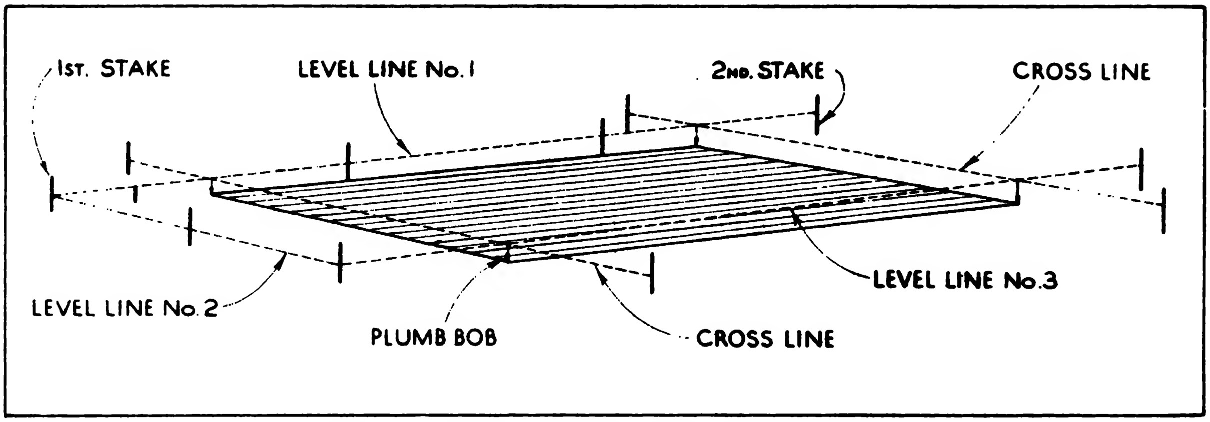


Fig.6 Method of Setting Out the Level Lines.

EXCAVATION

By means of a plumb bob, the exact corners of the foundations are marked on the ground. From these points, post holes and concrete piers are spaced out, and excavations for concrete walls, as well as for post holes and piers, are taken out. The datum height line can be stretched at any time that a check on levels is considered necessary.

SPECIFICATION

Materials ordered to specification are -

Soles	4" x 2"	Red Gum or Jarrah	4 / 3'6"	
Struts	4" x 2"	Red Gum or Jarrah	8 / 2'9"	
Posts	4" x 4"	Red Gum or Jarrah	2 / 11'	dressed.
Head	6" x 2"	K.D.Hardwood	1 / 8'	dressed.

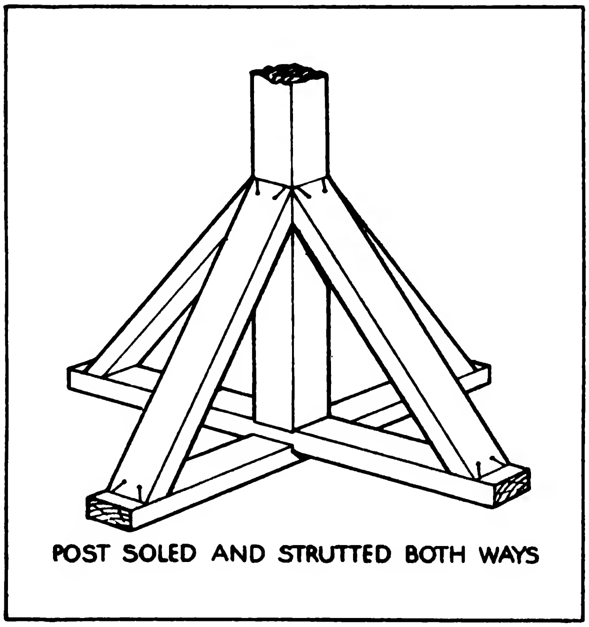


Fig.1 Door Post showing Soles and Struts.

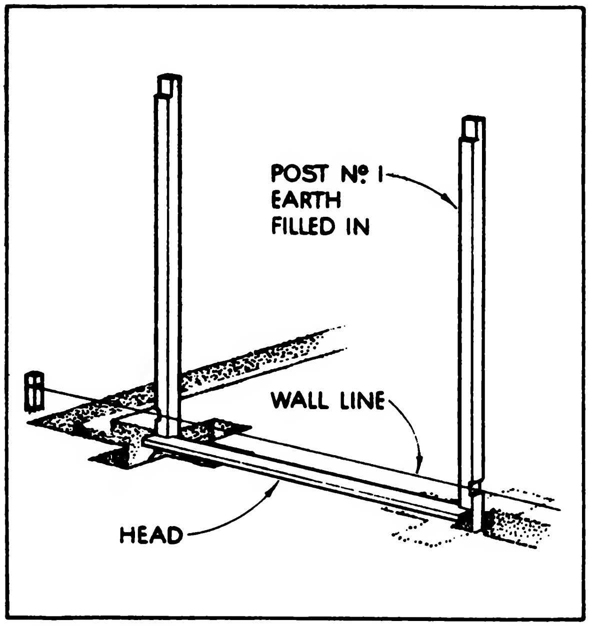


Fig.2 Checking the Width of the Door Opening.

DESCRIPTION

The bottoms of the posts are to be soled and strutted both ways, as shown in Fig. 1. The tops of the posts are cut to hold the head of the frame, and the underside of the head is shouldered to keep the correct spacing of the posts. The second sole on a post is fitted over the first by trenching out half its thickness at their intersection, and fixing it directly under the post.

OPERATIONS.

(i) Posts. Mark the face and edge and measure from the bottom of the excavation to the datum line. Make the necessary adjustment in height for the floor level and set out the bottom plate lines on the posts. Set out from the plate line on the pair of posts, the height to the head, and top cut. On these lines the cutting and trenching will be made. Complete the preparation of the posts by attaching the soles and the struts.

(ii) Head. Erect one post and check its position to the wall line and corner. Fill in and ram tightly to keep the post plumb. The second post is erected, and its distance along the wall line is checked with a measuring rod from the corner, and the width of the door opening by means of the head, as shown in Fig. 2, which is laid on the ground before fixing finally at the top of the posts. Levels must also be carefully checked and when the bottom of the post hole needs raising, sand should be used.

THE GENERAL SET UP.

Fig. 1 shows a detail drawing of part of the required foundation and indicates the type of construction being used. It will be noticed that the levels of the piers step down when spaced out on the sloping ground. Where the ground is reasonably level, as in the case of the cross walls, they would be all on one level. The carpenter relies on detail drawings to see the sizes of materials and how the various parts junction.

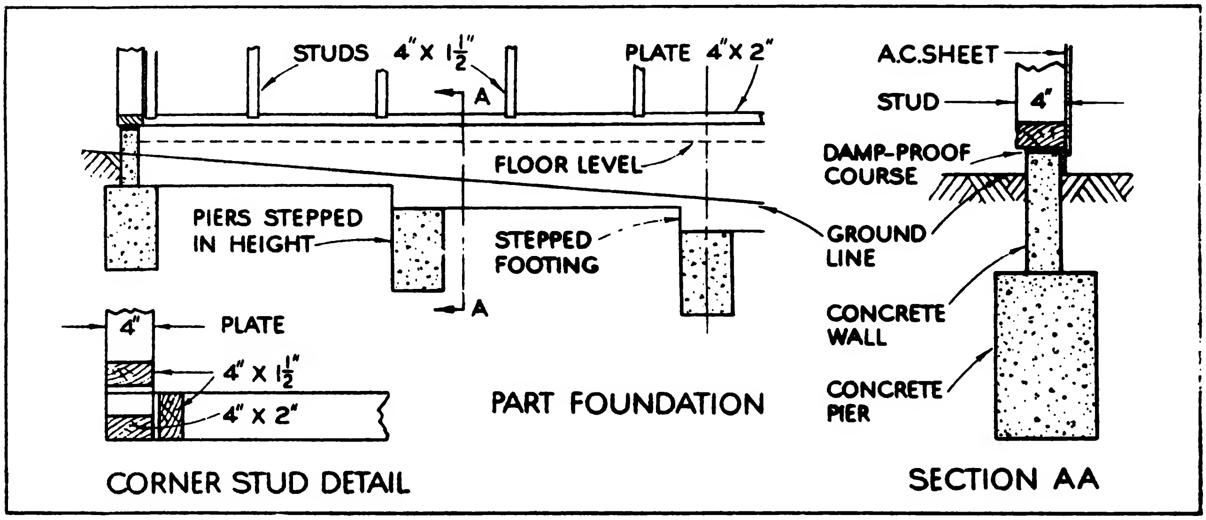


Fig.1 Detail Drawing showing type of Foundation and Construction.

Plans, elevations and written specifications do not always give sufficient information to clearly understand all that is required to be done. A difficult position, such as between the door frame and the corner of the foundation, is given as an isometric drawing, (Fig. 2). The ground has been taken away to reveal the whole concrete pier.

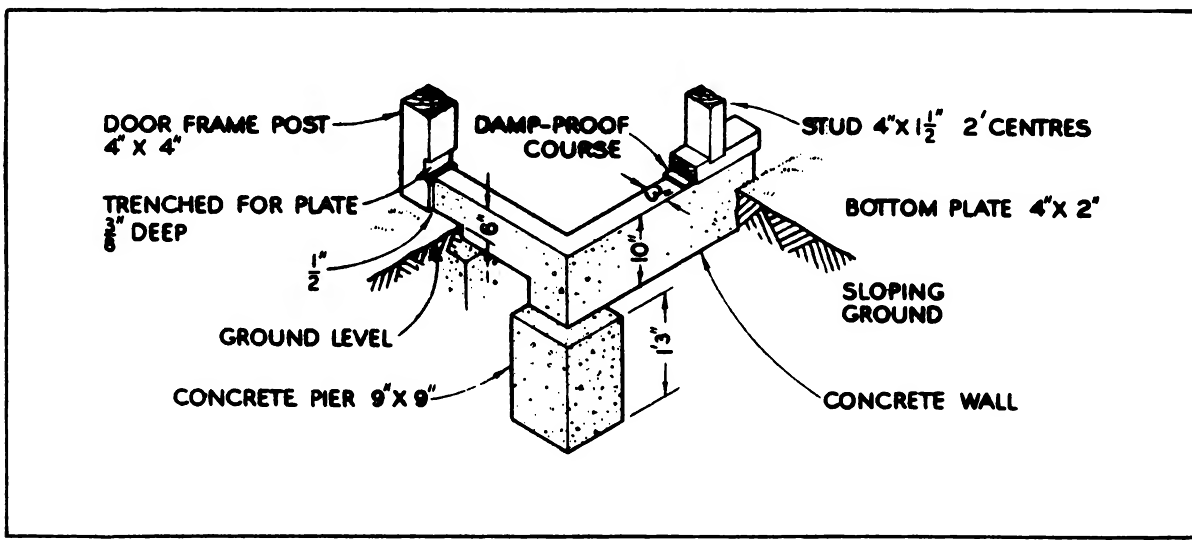


Fig.2 Details of Front Lower Corner of Garage.

Fig.3 shows the work that is required to be completed before the concrete is formed to its shape in the boxes, and should be referred to when required in the working description which follows, and especially when marking the lengths of the side panels.

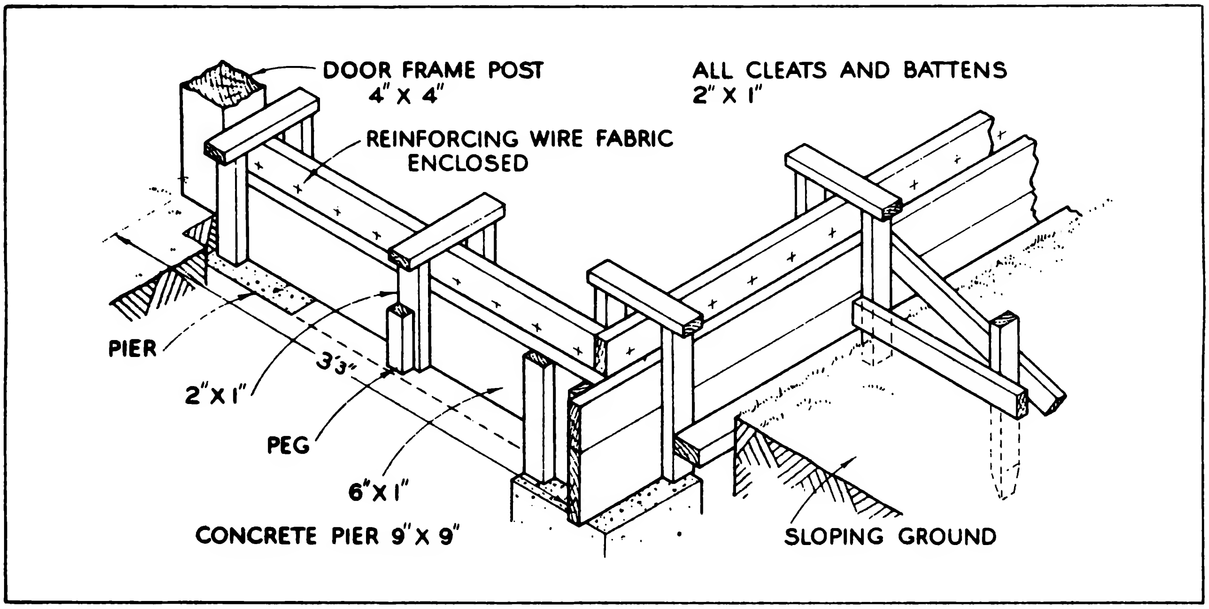


Fig.3 Details of Boxes to Form Concrete.

STAKING LEVELS.

Staked levels in concrete foundations indicate to the concretor the finished height of concrete required. In a small hole, as shown in Fig.4, one stake standing in the middle of the excavation should be sufficient. In a larger hole, stakes may be driven at the sides of the excavation with their tops at one level. The stakes remain in the concrete after it has been poured.

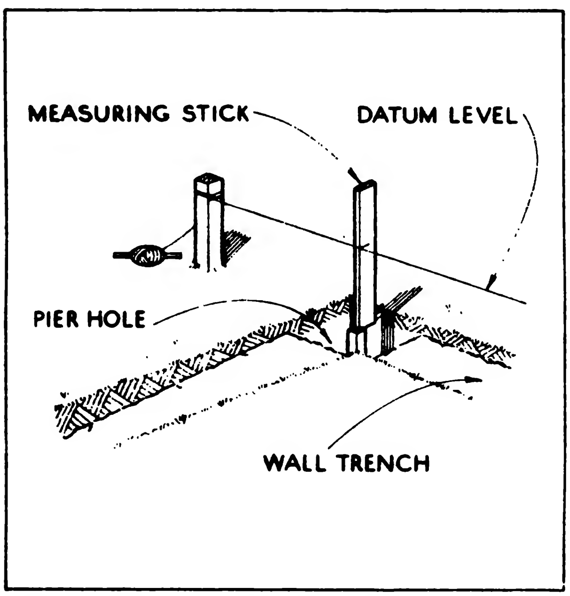


Fig.4 Method of indicating Height of Concrete.

Stakes cut from 1" x 1" battens are large enough for the purpose. They are cut to an approximate length and driven down to levels that are taken by measurement from the datum line already established. The top of the first pier will finish 1" below the ground line.

Commence at the lowest corner and make the back wall pier stakes on one level. Make the front wall pier stakes of suitable depth. On the sloping ground between the front and the back, make the pier levels step down in heights of suitable proportions. The heights can all be determined from the level datum line, a crow bar or axe being used to drive the stakes.

Reinforcing rods, $\frac{3}{8}$" diameter, bent to U-shape, are placed in the hole before pouring the concrete. The top ends of the bars must project high above the stake top, as shown in Fig.5, and are placed in wall lines to form a connection between the pier and the wall.

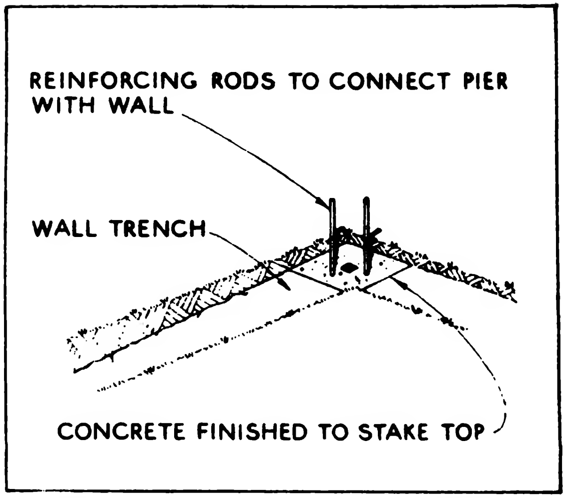


Fig.5 Rods to connect Piers and Walls.

CONCRETE FORMS.

Concrete forms for walls are made up in panels of sheathing, constructed with 1" boards of varying width, held together by cross ledges nailed at spaces of approximately 1'6". In a larger panel, heavy scantlings would be necessary.

The thickness and weight of concrete to be held in place determines the size of ledge required. For the small job in hand, 6" x 1" boards and 2" x 1" cleats will be utilized.

For each foundation wall a pair of sheathing panels must be made. A temporary bench, formed with timber scantling resting on saw stools, makes a good bench for working. The illustrations show only the saw stools, in order to avoid a number of lines which would be confusing.

MAKING THE PANELS.

To construct two wide panels for the back cross wall, select two pieces of 6" x 1" that are a little longer than that of the finished panels, mark their faces and top edges clearly, and lay them together in a pair on the bench. Tack the two pieces together with a few nails to prevent any movement while setting out.

Set out on the outside board the total length of the concrete wall. Set out the inside board 8" shorter, as allowance must be made at each end for a 3" thickness of concrete plus 1" thickness of board. The junctions of the walls are made as shown in Fig.3. Mark clearly across the boards the lines for the cleats, spacing them out at approximately 1'6" centres.

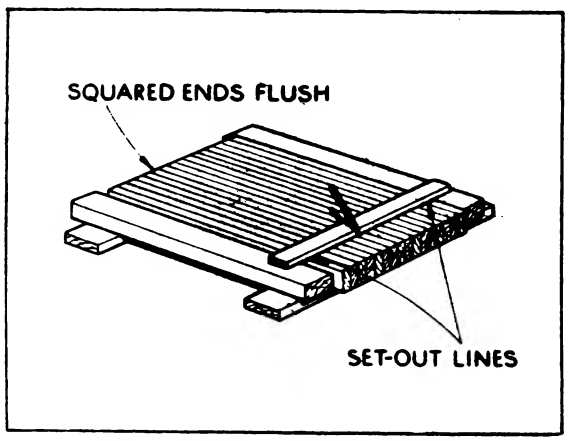


Fig.6 Method of Marking Cleats.

Cut the required number of cleats to their length and at 6" from one end mark on them the line for the top edge of the long boards. The marking is best done by squaring it around two cleats, then laying all the others on edge between them, and with a straight edge and pencil, carrying it across the stack as shown in Fig.6.

Pieces of flat thick materials placed alongside the stack will assist in keeping the cleats close together during the marking.

Nail the cleats squarely across the top of the board at set out lines, keeping the 6" margin length of cleats to line with its face edge, as shown in Fig. 7. When all are attached, turn the work upside down and nail other boards to the cleats until the required width is obtained. When boards are not the full length of the panel, they may be butt jointed at any point. If the joint comes between the cleats, a short fish plate of timber can be nailed over it. Clinch as few nails as possible, to allow the material to be salvaged in good condition when stripped from the wall.

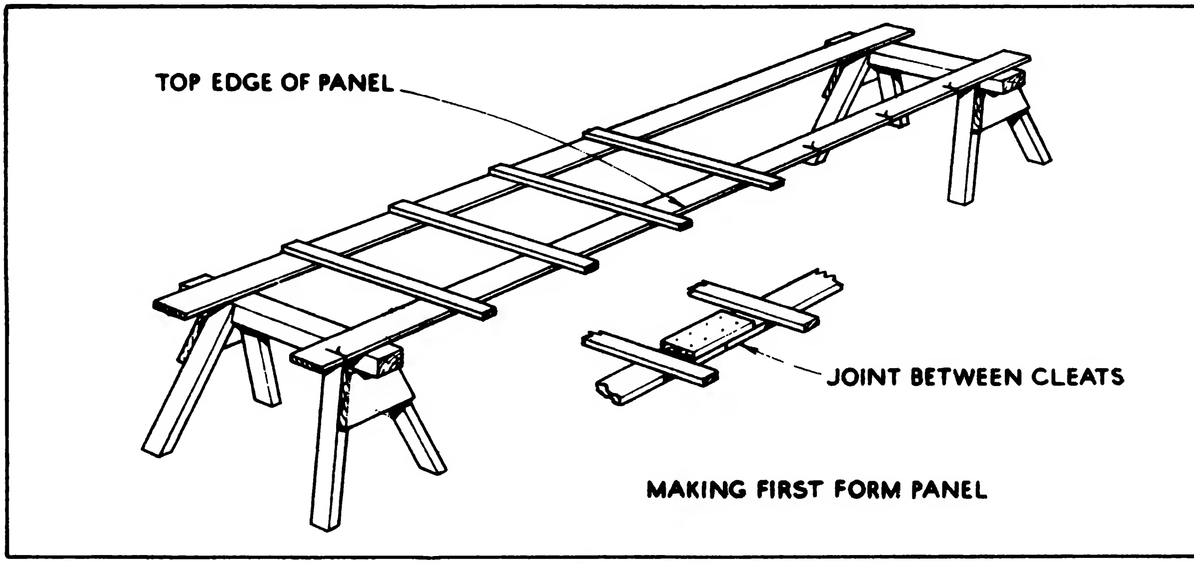


Fig.7 Attaching the Cleats to the First Form Panel.

The second panel is constructed by the same method as the first panel. The best position for this work is directly on top of the first panel, where a check can be kept by fixing the cleats directly opposite to those on the first panel, as shown in Fig. 8.

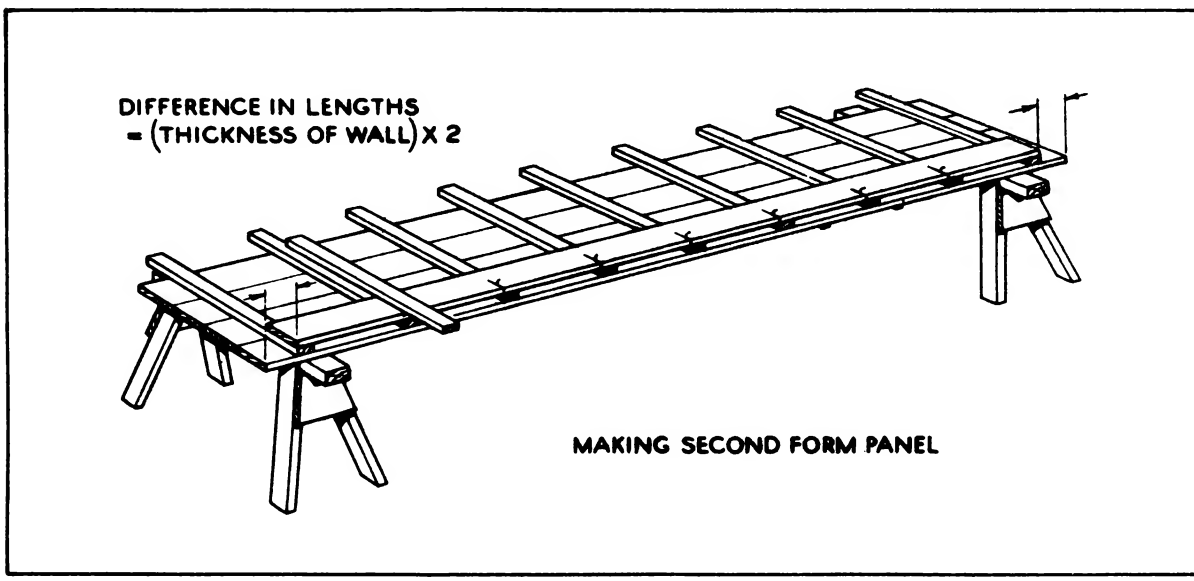


Fig.8 Second Form Panel Set Out and Constructed over the First.

The forms for the side walls are made as shown in Fig.9. The lengths are cut to meet the cross walls so that all junctions will nail securely together. Make four panels to form two walls and place in handy positions ready for erection.

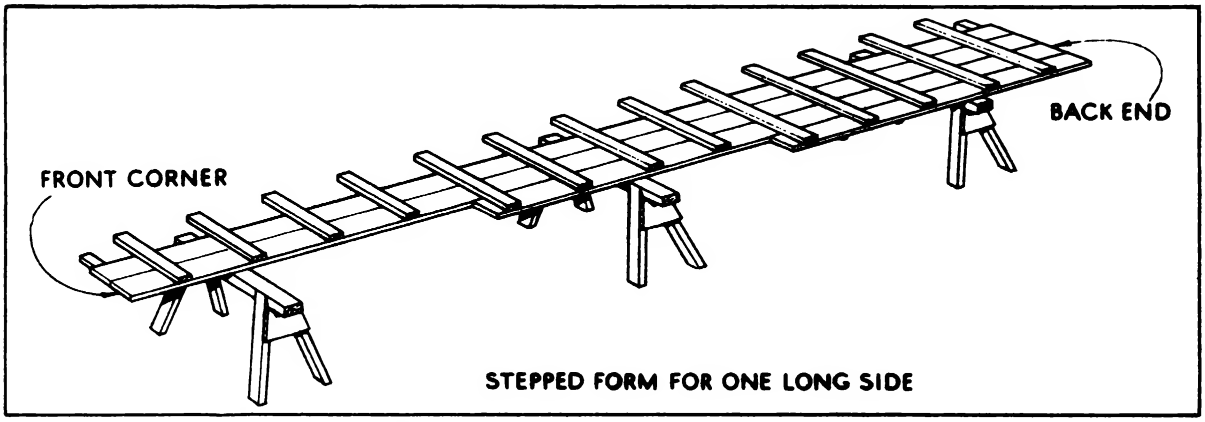


Fig.9 Setting Out the Stepped Form.

The surfaces of the forms are frequently treated with grease, or other waterproofing material, to prevent the concrete adhering to the boards, thus allowing them to be used again.

ERECTING THE FORMS.

Erect the outside panel of the cross wall, securing it by means of pegs, and with level scantlings to maintain a straight line of wall. Place inside it the lengths of wire fabric reinforcement. Spreaders of battens, cut in length to the thickness of the wall, are spaced out and fixed between the two panels. Short battens are nailed across the top projecting ledges to bind the tops together, as shown in Fig. 10.

Anchor bolts must be fixed in place before the concrete is poured. They hold the wall plates on the concrete base when the walls are erected. Space out at approx. 4' centres and suspend in position through short lengths of materials of the same thickness as the plate. Nail these to the top edges of the forms, as shown in Fig. 11.

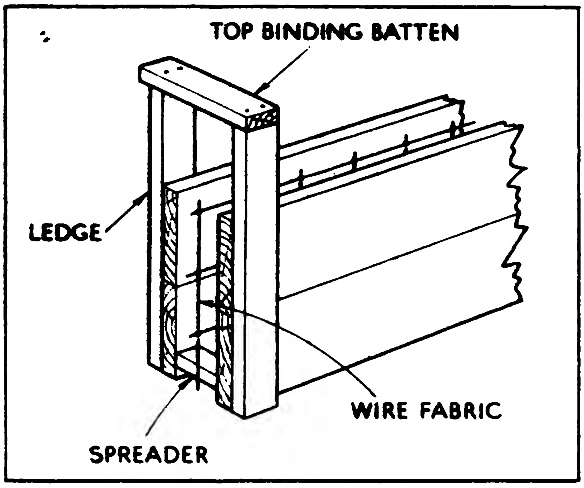


Fig.10. Method of Binding the Tops of the Forms.

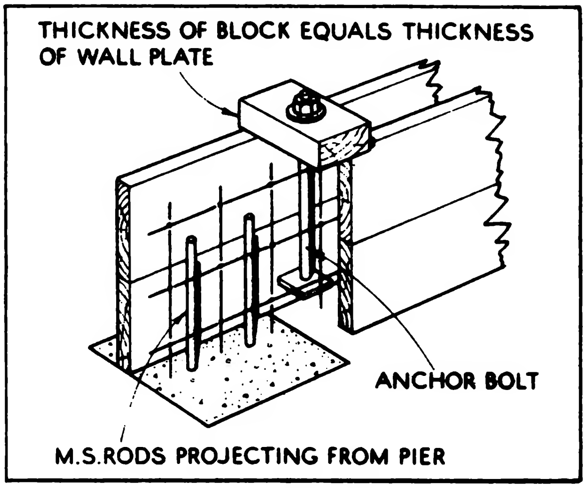


Fig.11 Fixing the Anchor Bolts in Position.

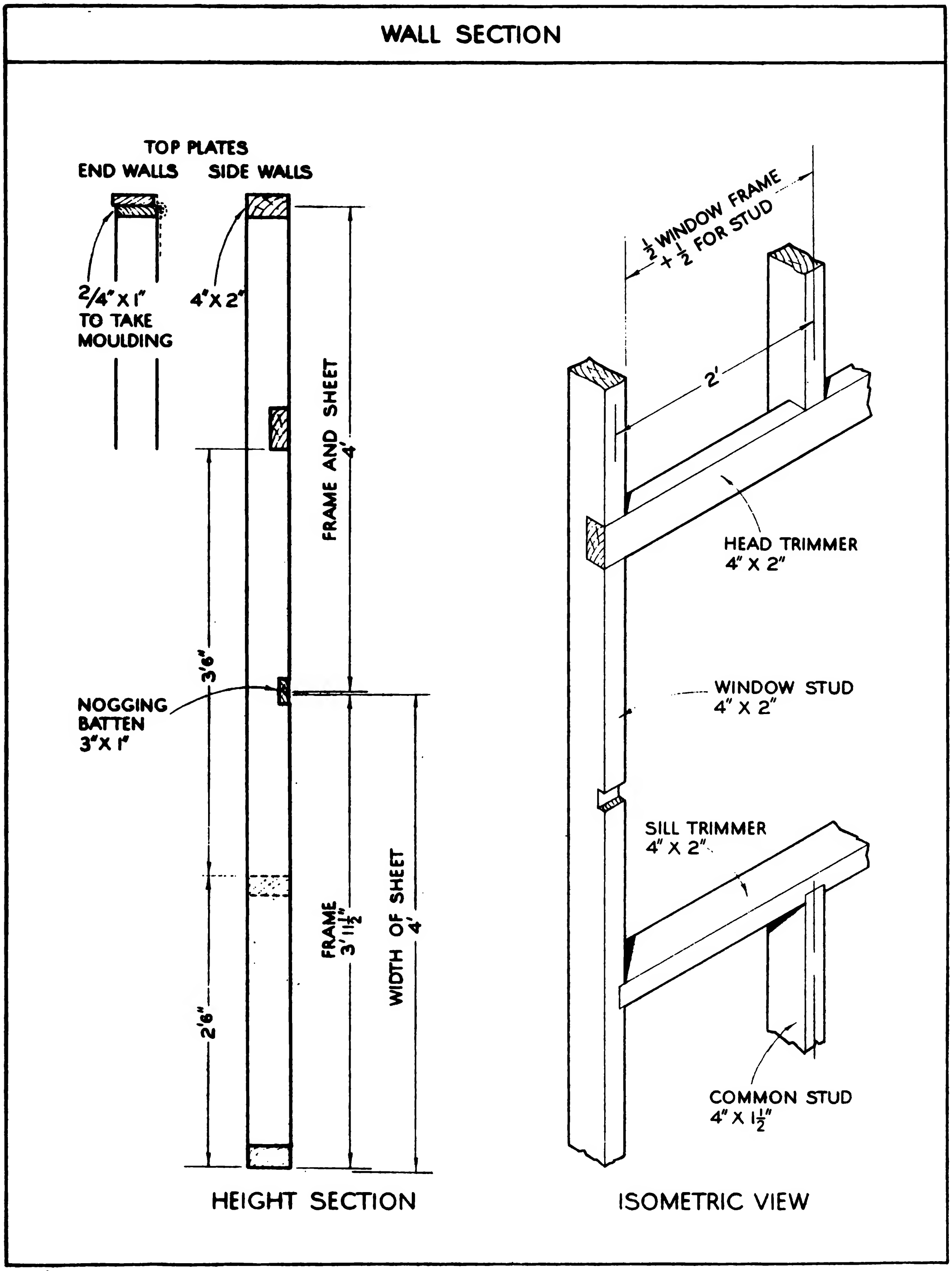


Fig.1 Details of Wall Construction

WALL FRAME FOR HORIZONTAL SHEETS.

Asbestos cement sheets are manufactured in a standard width of 4 feet, and when fixed horizontally, require framing timber to back up their edges. At the top and bottom of the wall, the plates serve this purpose. On the wall with a gable spandrel, the top plate may be in two pieces, as shown in the height section in Fig. 1.

The plate made up in these two laminations makes provision for forming a rebate to take a horizontal line of moulding that is fixed between the overhanging plates of the long walls. The gable studs are fixed with their face edges in line with those of the lower laminations of the plate. This treatment is not required in the long wall plates as no horizontal joint on them is exposed to the weather and therefore has no moulding.

At the top and bottom of the windows metal flashing is used to weatherproof the horizontal edges of the asbestos cement sheets

When preparing the studs, all the trimmer housings are trenched out and the face edges of the two members are kept flush when nailed in position, as shown in the isometric view in Fig. 1.

Nogging battens are required between the studs to stiffen up the junction of sheets and moulding. These battens are cut to fit against the braces of the walls and the corner studs but are trenched into the edges of the studs. Firring laths, equal to the thickness of the moulding, are nailed to the battens on their lower half widths, as shown in Fig. 2.

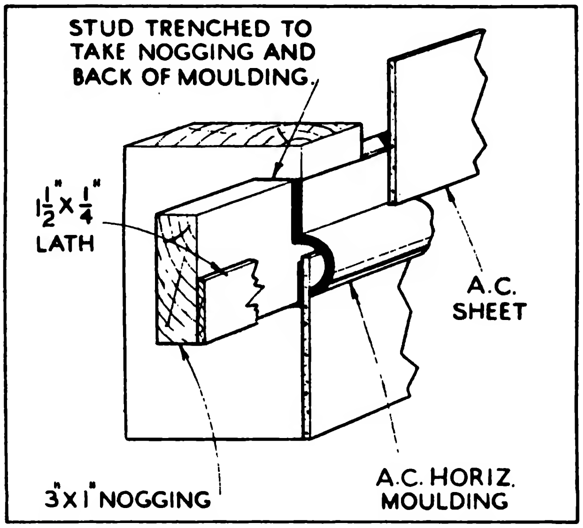


Fig.2 Stud prepared for Horizontal Moulding.

When first making up the wall frames it must be remembered that the diagonal braces of these structures are housed ¼" below the face edges of both wall plates and studs so that their thickness will not need to be cut thinner where the moulding crosses them.

CONSTRUCTING THE WALL FRAME.

Set out the wall plates for corner halvings, studs at 2' centres, and holes for anchor bolts. Halve, trench, and bore the plates. The holes in the wall plates should be a loose fit over the anchor bolts to allow the walls to be easily dropped over them. Washers below the nuts allow them to be tightened.

Cut the number of studs to a common length, trench them for battens and trimmers, and nail them in the plates. Brace the wall frame square, with the face of the braces at the back line of the mould. Erect all the frames on the concrete base.

ROOF SPECIFICATION.

Materials ordered to specification for the roof are :-

Rafters	4" x $1\frac{1}{2}$"	Hardwood at 3' centres.
Ridge	8" x 1"	Hardwood
Battens	3" x $1\frac{1}{2}$"	Hardwood spaced at 3' maximum.
Sheets	standard	Asbestos cement corrugation.

Width of building, measured on top plates = 14 ft.
Eave overhang, obtained from plans = 1 ft.
Length of corrugated sheets, as delivered = 9 ft.

METHODS OF SETTING OUT RAFTERS.

In setting out a common rafter for a gable roof, "Setting Out with a Steel Square" has an advantage over "Setting Out on the Ground", in that it can be done in a small space, either on the timber or on a set out board on the bench. Setting out gable rafters is a comparatively simple problem.

The successful solution of steel square problems depends on very accurate measurements being taken. There are several methods of using the square, each of which may appeal to some carpenters more than to others. The method adopted in this case is that of taking the dimensions directly to the timber from the edges of the square, which are graduated in inches and twelfths, and specially designed for the purpose of making a set out to the scale of 1" = 1'. Fig. 1 shows a complete section of the roof that is to be set out for the garage in this project. The steel square should be visualized as a small representation of the right angle made at the junction of a horizontal and a vertical line, with the rafter as the third side of the triangle, such as that made on the rafter timber shown in the circle of Fig. 1.

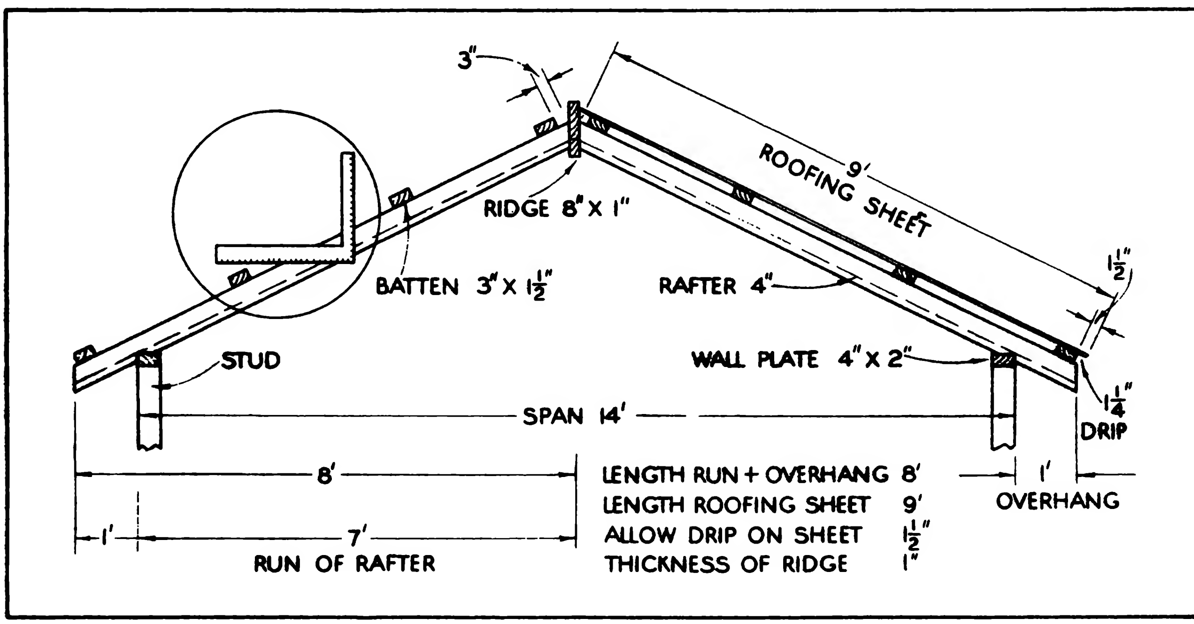


Fig. 1 The Right Angled Triangle formed by the Steel Square and Rafter Pitch Line.

THE STEEL SQUARE.

In order to use the square as a bevel for marking the same angles on a number of rafters, it is necessary to attach to it a "fence". Several types of fences may be purchased, or they may be constructed by the carpenter.

A very efficient type of fence shown in Fig. 2, consists of two pieces $1\frac{1}{2}$" x $\frac{3}{8}$", and approximately 2'9" long, screwed to each other at the ends through short pieces of packing $\frac{1}{8}$" thick.

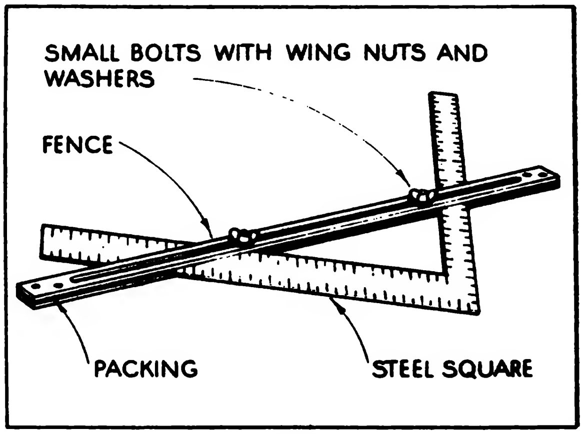


Fig.2 The Steel Square and its Fence.

The packing allows the square to slide freely in the space between the packing.

The top and bottom of the fence are slotted to allow bolts with wing nuts to be used to hold the square securely in any desired position when it is being used as a bevel for marking timber.

To test the accuracy of the dimensions which are to be transposed from the steel square to the timber when the square is laid down flat, a small templet, as shown in Fig. 3, should be used.

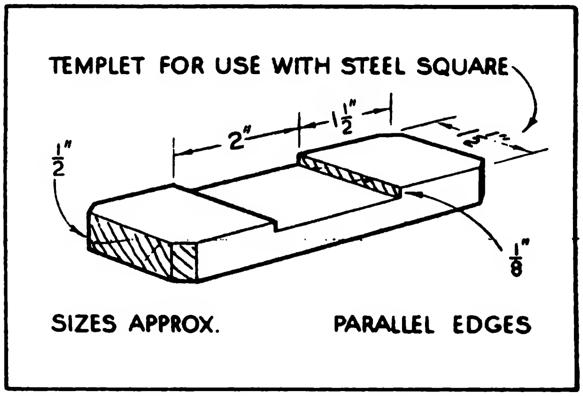


Fig.3 Templet for use with the Steel Square.

The templet must have square parallel edges. Across one of its sides it has a trench 2" wide, to fit neatly over the steel square. The method of using the templet is described later.

SETTING OUT LENGTH AND BEVELS OF RAFTERS.

Close to the position of the set out, make a record of the following measurements :-

(a) Half span and thickness of ridge timber.
(b) Width of overhang.
(c) Length of corrugated sheet.
(d) Length of pitch line.

Check up the measurements from the actual material before recording them. The length of the pitch line will be $1\frac{1}{2}$" shorter than the corrugated sheet to give the projection into the spouting which makes a clear drip for rain water from the sheet to the spout. The $1\frac{1}{2}$" used is an average amount, and on a flatter or steeper pitch may need to be varied to suit the fall along the length of the spouting. This $1\frac{1}{2}$" does not allow for a fascia board being used.

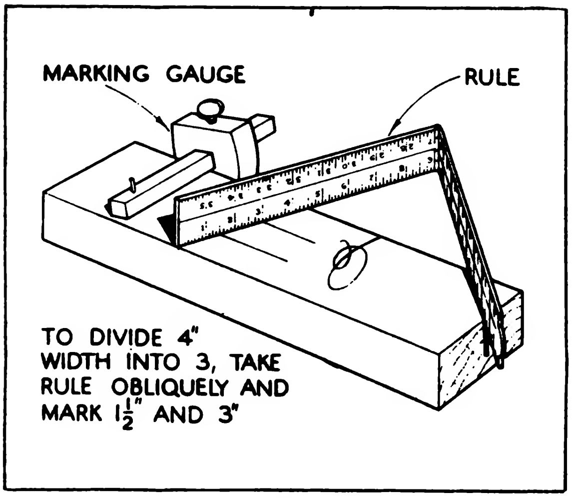


Fig.4 Dividing Rafter Width into 3 Equal Parts.

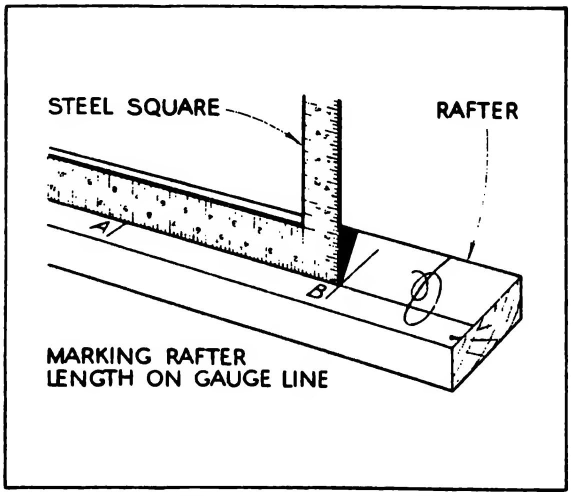


Fig.5 Marking Length of Pitch Line.

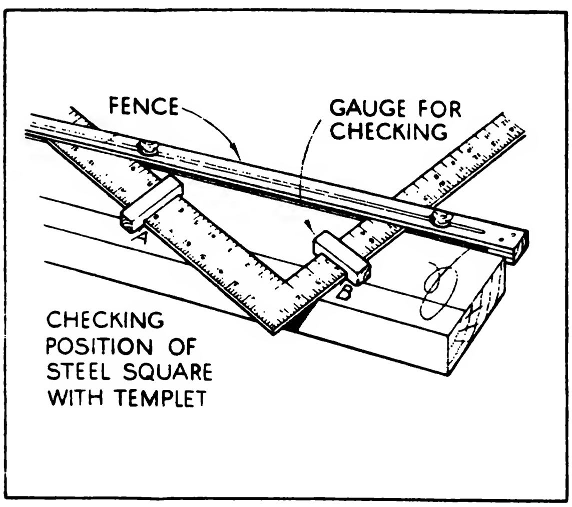


Fig.6 Setting Out the Level Cut and Plumb Cut.

One straight clean length of rafter is required. If necessary, take a shaving off the face of the timber to allow good reading of pencil lines, then proceed as follows :-

(i) Mark the face and edge of the rafter in the usual way. Divide the width of the face into three, and gauge from the face edge a clear line at two thirds the width of the timber which is the minimum amount of timber that must be left above the birds-mouth cut. To divide 4" into three parts, place the rule obliquely, to register 4½" between the edges of the timber, as shown in Fig.4, and mark the 3" and 1½" from the rule. The 1½" point is extended in a gauge line. The face edge of the rafter must be on the opposite side to the setter out.

(ii) Mark with pencil and try square on the gauge line, to the scale of 1" = 1', the finished length of the pitch line measured in feet, inches and parts of an inch, as accurately as possible from the graduations on the edge of the steel square, as shown in Fig.5. Letter the points of the length as A and B.

(iii) Place the wooden templet within easy reach and lay the steel square flat on the material. The 2" blade faces away to the left, the 1½" tongue faces away to the right, and the right angled corner is near the setter out, as shown in Fig.6. Hold the square with 8" measurement on the blade directly over the point A on the gauge line, and using it as a pivot, swing the tongue around to the position indicated in the sketch. The edge of the tongue is exactly on point B.

(iv) Check the position of the square on the points A and B with the aid of the templet held squarely across the blade and then the tongue, as shown in Fig.6.

When the square is in the correct position, mark on the timber with close up pencil lines, the edges of the steel square. Remove the square and a scale drawing of the pitch line will be seen on the rafter, and across the pitch line the two bevels for cutting rafters.

The incomplete triangle measures:

Base	=	8	inches.
Height	=	$3\frac{10\frac{1}{2}}{12}$	inches.
Hypotenuse	=	$8\frac{10\frac{1}{2}}{12}$	inches.

As soon as the set out is completed the setter out should view his work from a little to the left of his working position, and visualize the direction in which his bevels will be placed when erected in position. These are indicated in Fig. 7.

MARKING THE PATTERN RAFTER.

(i) To use the square for marking out the rafters, the fence must be attached as shown in Fig.8, with the edges of the square placed directly over the set out lines.

Keep as long a length of the fence as possible on the right hand side running past the plumb cut bevel.

(ii) Commencing on the pattern rafter, mark the plumb cut at the ridge end, and after measuring the full length of 8'10½" along the rafter, mark the plumb cut of the eaves.

The extra length of fence that was advised to be left outside the plumb cut is of assistance when marking an eaves bevel at the end of a piece of stuff, as shown in Fig.9.

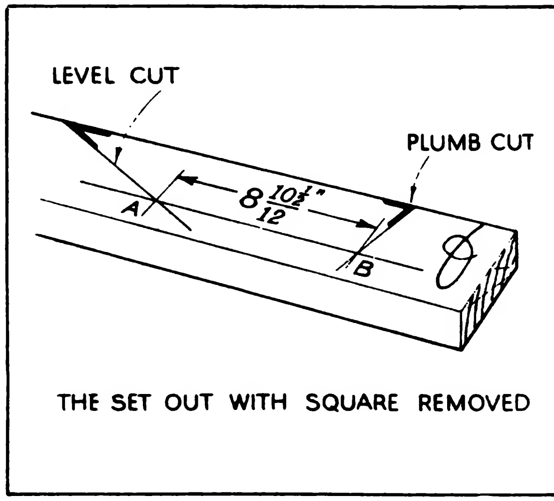


Fig.7 Level Cut and Plumb Cut marked on Rafter.

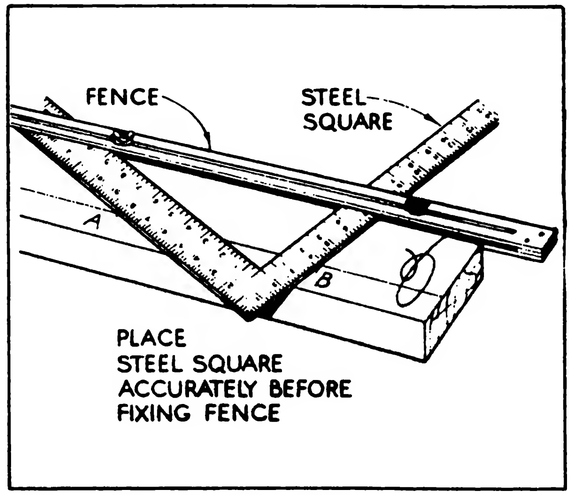


Fig.8 Square Set for marking Pattern Rafter.

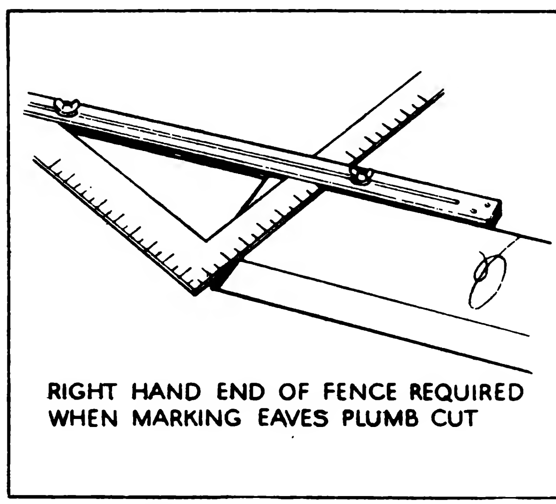


Fig.9 Method of marking Eaves Plumb Cut.

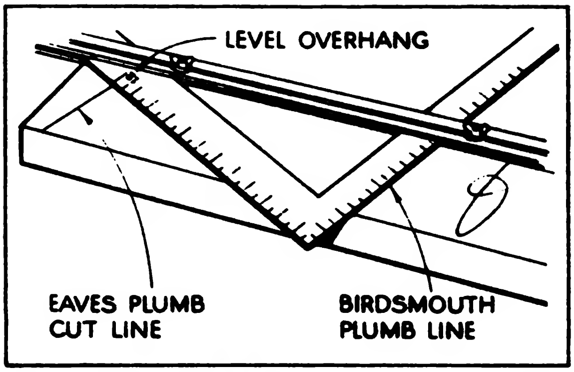


Fig.10 Method of marking Birdsmouth Plumb Cut.

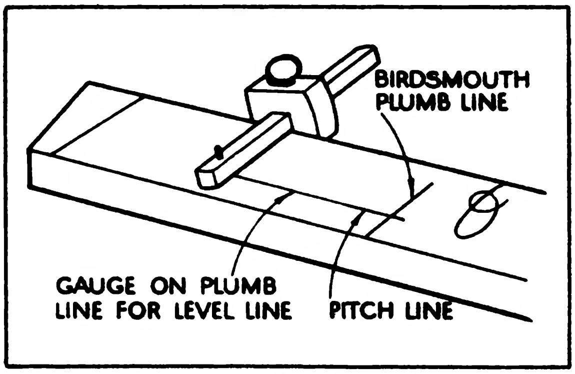


Fig.11 Gauging the Depth of the Birdsmouth Cut.

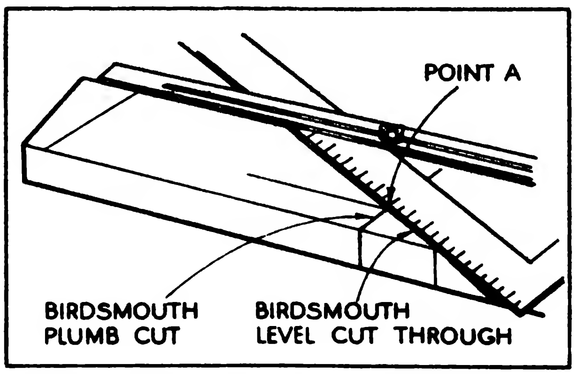


Fig.12 Marking Level Cut for Birdsmouth Cut.

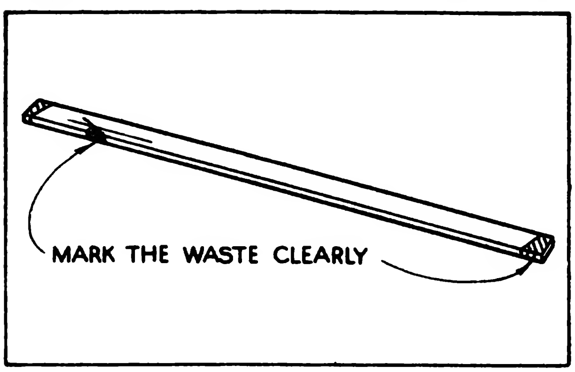


Fig.13 Indicating the Waste with Hatched Lines.

(iii) The birdsmouth cut is given its first mark, a plumb line, when the square is moved along the rafter to a position shown in Fig. 10. The square must show the level width of overhang (12") on its blade, directly over the eaves plumb cut. If the amount of overhang on any other rafter should be more than 12", and outside the length of blade available for measurement, it can be taken in more than one step.

(iv) Gauge part of the pitch line across the birdsmouth plumb cut at two-thirds the width of the rafter as shown in Fig. 11.

(v) Place the square on the intersection of the pitch line and the birdsmouth plumb cut (point A), and mark a level cut to give the complete shape, as shown in Fig. 12.

(vi) Square through the thickness of the rafter with a try square all the lines marked on the width. Mark the waste to be cut off with hatched lines, as shown in Fig. 13. This completes the marking of the pattern rafter.

Cut the required number of rafters at the plumb line for the ridge end and the whole of the birdsmouth for the wall plate. Leave the eaves line to cut after erection.

Dress the timber that is going to be exposed outside the building, such as at gables, also between walls and eaves, before stacking it away at convenient positions.

A gable roof for asbestos cement sheets is constructed mainly on the same lines as one for corrugated iron. The rafters are spaced at a maximum of 3' centres, the braces and gable studs are fixed to the rafters, and the usual procedure followed.

COVERING THE WALLS.

Asbestos cement sheeting laid with the joints horizontal is nailed to the studs. A temporary support will be necessary to gauge the height of the bottom sheets when the work is carried out single handed.

The vertical joints are made weatherproof by a metal strip attached to the stud, as shown in Fig. 1. The bead on this metal strip forms an inconspicuous joint, and the vees, by breaking contact with the back of the sheet, form a gutter to drain away any moisture that may filter through the joint.

Fix the bottom row of sheets and attach the moulding to the studs and nogging. Specially prepared pieces of mould enable the moulding to be carried around corners without mitre cuts. The top row of sheets is then fixed above the moulding.

COVERING THE ROOF.

Corrugated asbestos cement roofing is made in a standard width of 2' $7\frac{1}{2}$" for fixing with a side lap of $1\frac{1}{2}$ corrugations, as shown in Fig. 2. All holes in the sheets should be drilled, not punched, the diameter of the hole being about $\frac{1}{32}$" greater than that of the drive screw. The screws must be dipped in plastic bitumen to seal the holes in the sheets, care being taken not to screw or drive down too tightly. Use $2\frac{1}{2}$" x 12" for two thicknesses. Each sheet should be secured at each second and seventh corrugation, and on no account must sheets be screwed or bolted through the first corrugation.

The ridging is formed with two pieces of moulding, as shown in Fig. 3. This requires the top battens to be fixed in slightly different positions from those required for iron ridging.

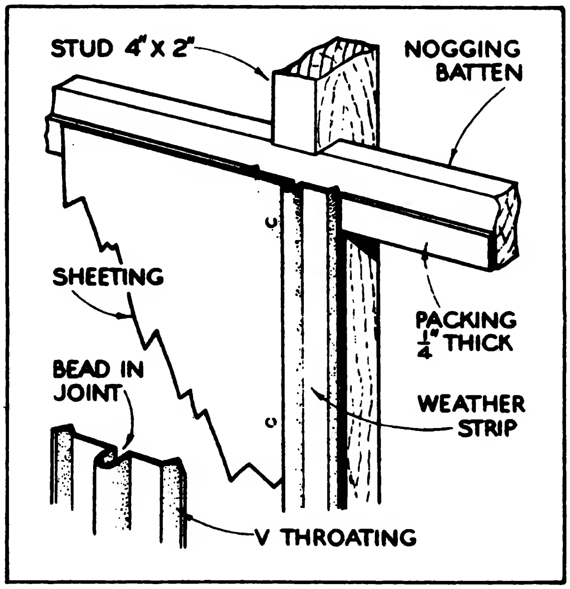


Fig.1 Weatherproofing the Vertical Joints.

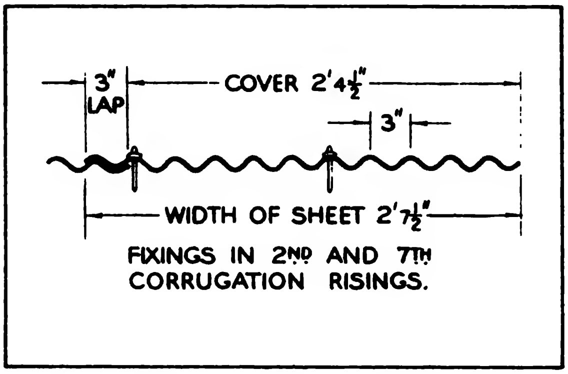


Fig.2 Method of Fixing Corrugated Sheets.

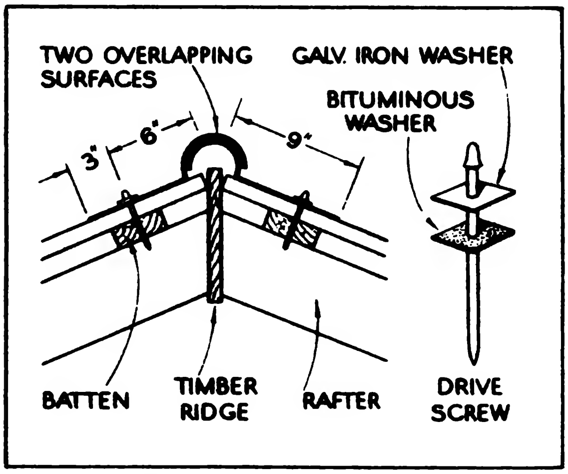


Fig.3 Detail of Mouldings to form Ridge.

FIXING THE WINDOW FRAME.

A dual casement window frame, as shown in Fig.1, is specified. It is distinct from a casement window frame for a pair of sashes, in that it has two separate openings for the sashes, while one for a "pair of sashes", sometimes called "twin sashes", would have only one wide opening and the two closing stiles of the sashes meet at the middle of the opening in a rebated joint. The mullion in the frame stiffens up the frame and maintains the straight line of the head by preventing it from sagging. Both sides of the mullion are rebated to form stops for the sashes.

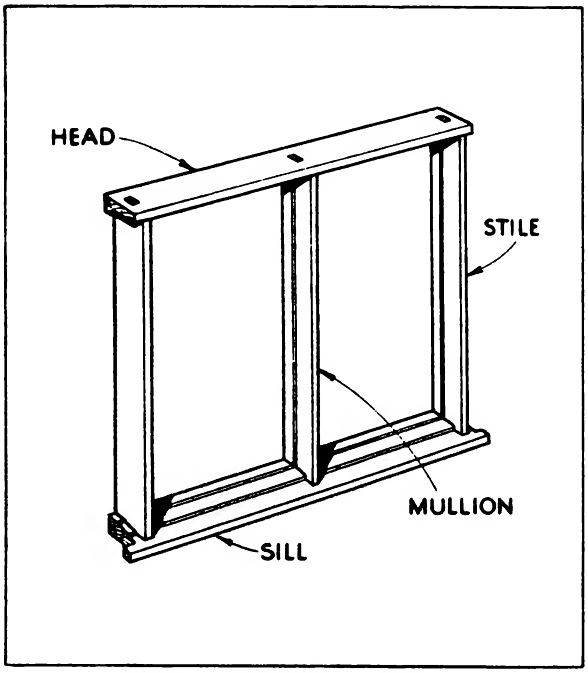


Fig.1 Dual Casement Frame.

The casement frame for this job is made of solid rebated material which has mortise and tenon joints.

The head has a drip groove close to the outside of its underneath side to break the flow of rain water that might continue from down the wall to run over the sash and onwards to the inside of the frame. The same provision is made on the bottom of the window sill to break the flow of water that would otherwise run in under the sill. Instead of continuing to flow, the water drips off, hence the name "drip groove".

Throatings, or half round grooves, are made on the rebates of the frame. They bank up a quantity of water and prevent it from quickly turning a corner.

In the stiles and mullions, these throatings make good drainage courses for water driven inwards through the joint between the sashes and the frame, to run downwards and escape over the sill.

The window frame is fixed in the opening built in the wall frame after all the walls are erected and the roof constructed in anticipation of the frames being exposed to the weather for as short a time as possible. Part sections of the frame and sashes, illustrated in Fig.2, show how the frame will stand in the wall when the surrounding parts are completed, and indicates how its face line must be placed in relation to the face line of the studs.

Notice must also be given to the lines of the flashing both under the sill and over the architrave, so that when cement sheets are being cut they will fit along the lines that are shown.

Care must be taken to ensure that the sill is level along its length and that with the stiles plumb there is no twist between them.

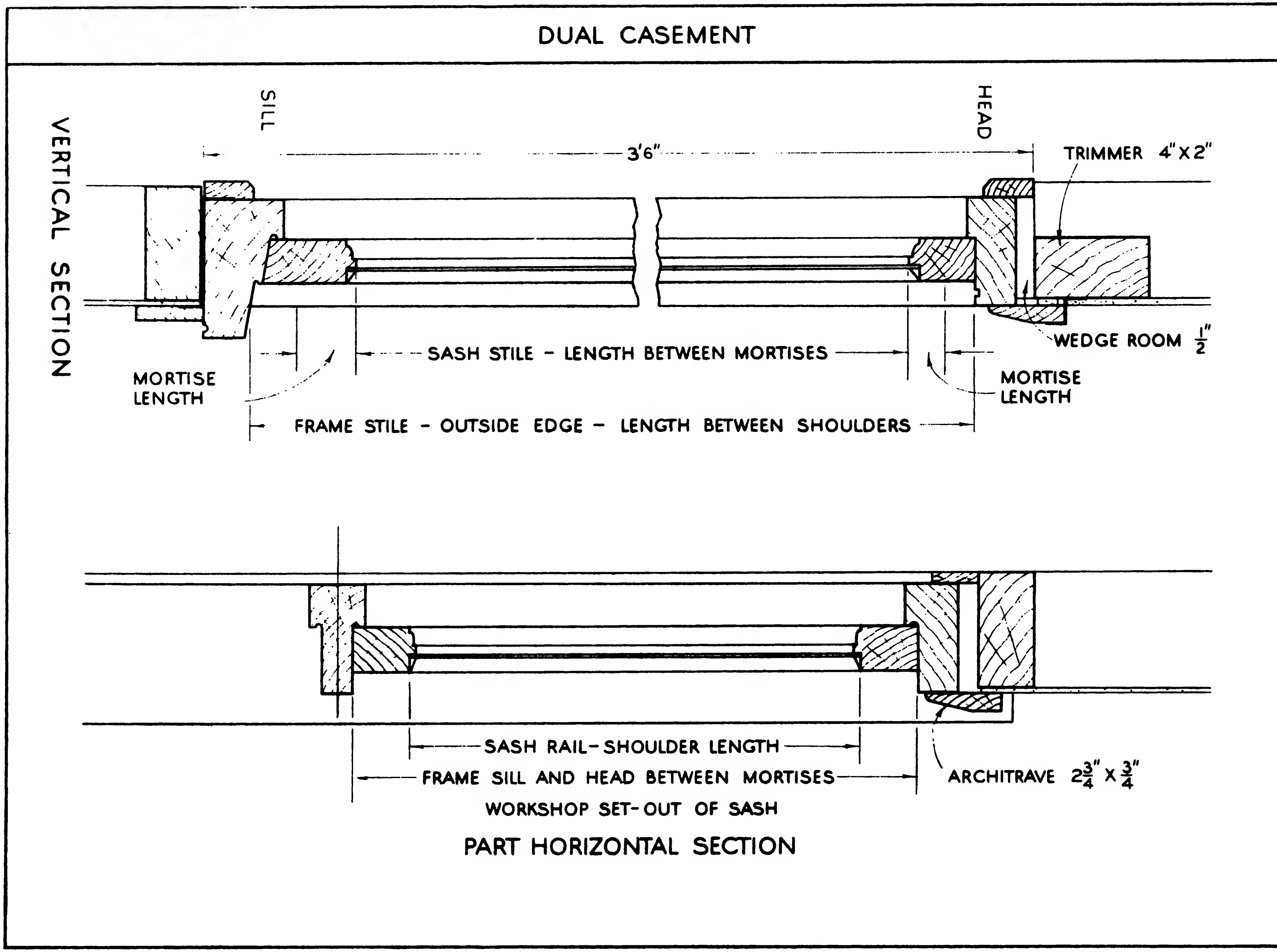


Fig.2 Sections of Dual Casement Frame and Sashes.

THE HINGES.

The doors are similar to those commonly used in private garages and were illustrated and described in building the previous garage.

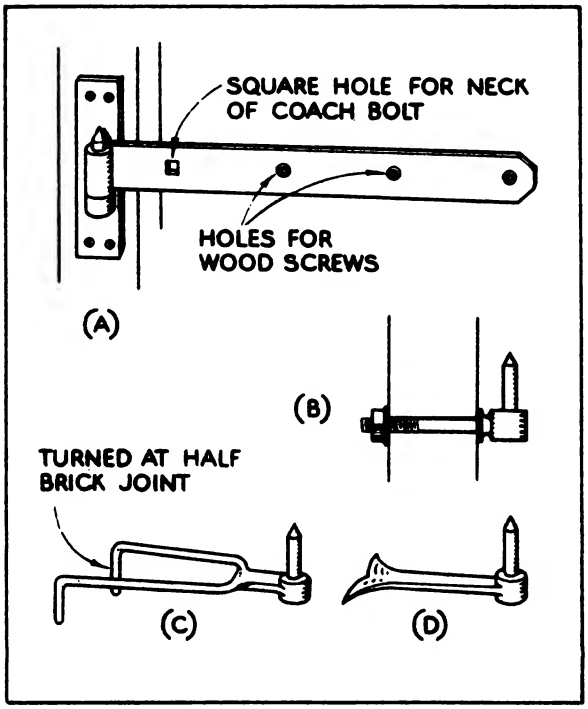


Fig.1 Hook and Eye Hinges.

The hinges specified are of different style. The doors are to be hung with 12" hook and eye hinges, sometimes referred to as Cross Garnet Hinges, and secured with coach bolts.

Hook and Eye Hinges, as shown in Fig. 1, have advantages of adjustment in fixing and hanging which are not possible with other types of hinges. Constructed in wrought iron, they show prominently on the opening side of the door and are used only where great strength is required.

These hinges are made either with hooks on plates for attaching them by screws to wooden posts, or with bolts to hold through the posts as shown in Fig. 1A and Fig. 1B. They are also obtainable with bends or fishtails for anchoring into brick-work, as shown in Figs. 1C and 1D.

The main advantages of hook and eye hinges are :-

(i) The bolt or fish tail allows the position from the edge of the post or brick to be placed so as to lift the bottom of the closing edge of the door over high ground. This also acts as a door closer when the door is opened not more than 90°.

(ii) During fitting, the door may be lifted down for a final shaving to be taken off without removing any screws.

METHOD OF FIXING HOOK AND EYE HINGES.

When the doors have been fitted, stand them up in position, keeping the top rail close to the head of the frame. Have the hooks already screwed to the post, or bolted in position. Drop the eyes on the hooks and mark the screw holes on the doors. The hinges are easily turned aside while the holes are being bored.

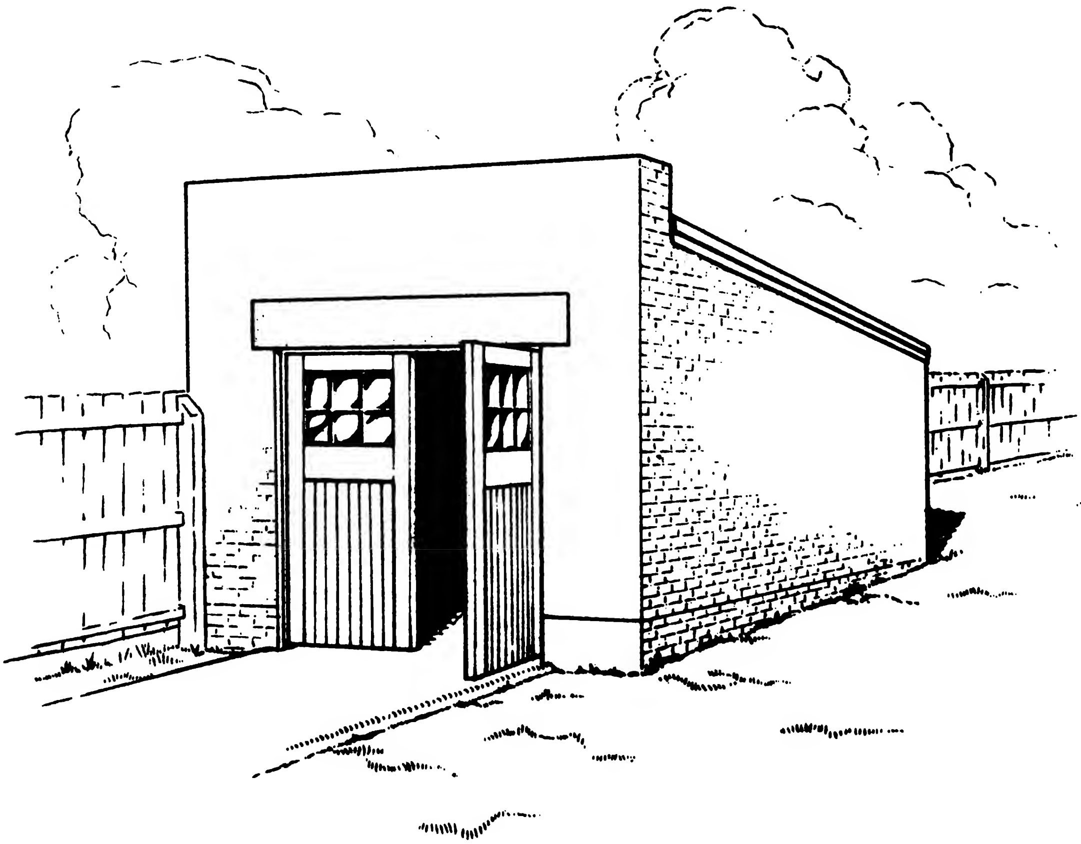
FINAL OPERATIONS.

After the doors have been hung, the hanging of windows and fixing of moulds will follow in the usual order of procedure.

Material that has been stripped from concrete forms and which has only been used once, is stacked together for removal for further use elsewhere.

When the earth filling has settled compactly in place, the concrete floor is laid.

SECTION 18. ERECTION OF A BRICK GARAGE WITH HINGED DOORS



PICTORIAL VIEW OF GARAGE

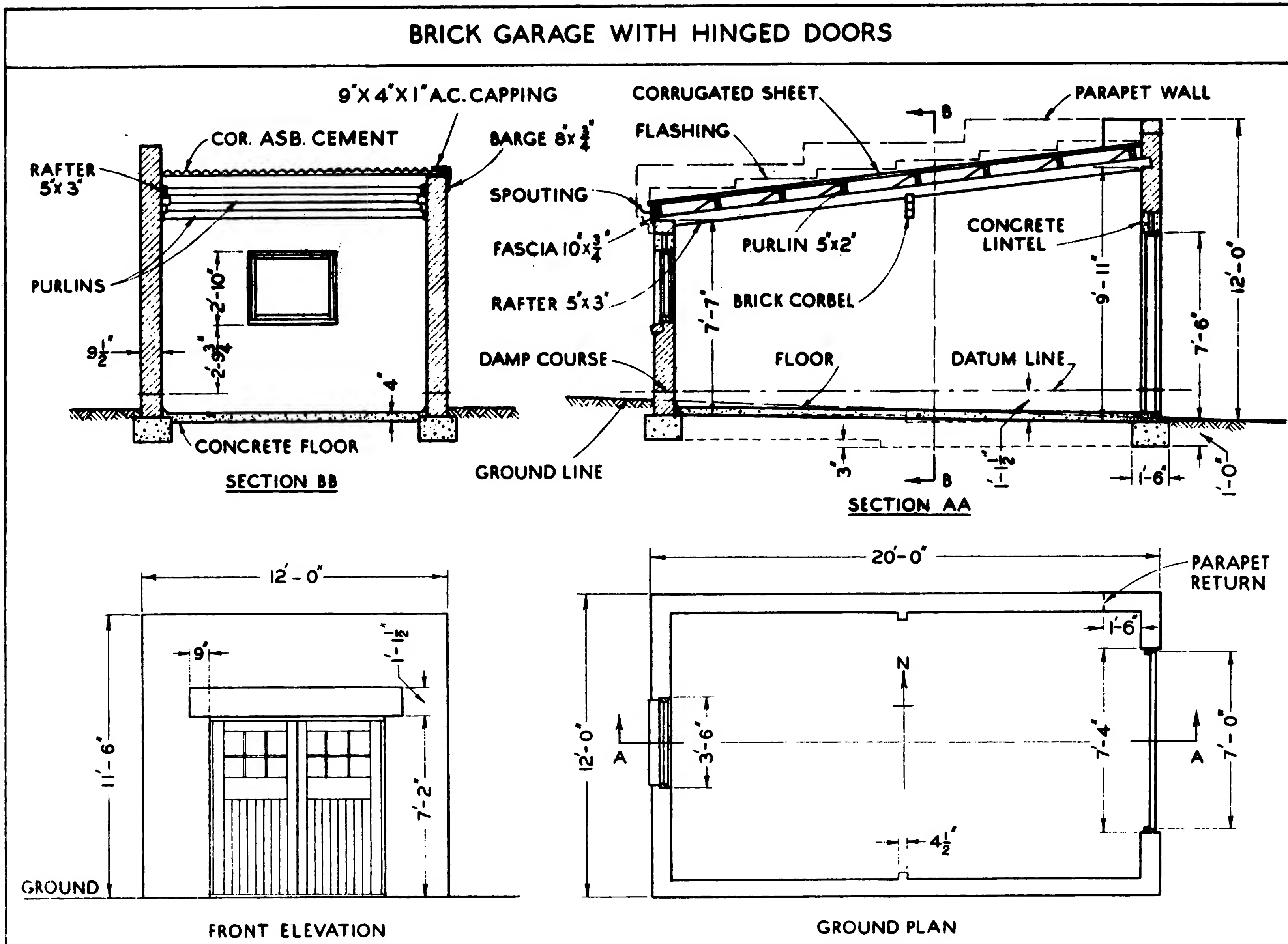


Fig.1 Plan of Garage.

GENERAL SPECIFICATION.

The garage is a detached brick building and has a skillion roof covered with corrugated asbestos cement sheets. It is to be erected to the following specifications and the dimensions shown in the accompanying plans and detailed drawings.

SPECIFICATION OF MATERIALS.

FOUNDATION:

Concrete foundation to all walls, 12" deep x 18" wide.
Mixture - Cement 1 part, Sand $2\frac{1}{2}$ parts, Metal 5 parts.
Reinforcement - 2 steel rods, $\frac{1}{2}$" diameter, with wire fabrication.

WALLS:

Brickwork, nominal 9" thickness in stretcher bond with wire ties.

Damp Course, approved waterproof material in courses above ground level and below tops of parapets.

Lintel over Door Frame, No.2 Four Course pre-cast reinforced concrete.
Lintel over Window Frame, No.2 Two Course pre-cast reinforced concrete.

ROOF:

Rafters	5" x 3"	Hardwood.
Purlins	5" x 2"	Hardwood, at 3' centres.
Purlin Blocks	5" x 2"	Hardwood.
Fascia	10" x $\frac{3}{4}$"	Oregon, dressed.
Barge Board	8" x $\frac{3}{4}$"	Oregon, dressed, covered with asbestos cement mould.

Roof Covering, corrugated asbestos cement of standard pattern.
Parapet Wall Flashing, asbestos cement mould and galvanised iron.
Eaves Gutters and Downpipes, asbestos cement moulded.

DOOR FRAME:

Head	6" x 3"	to detail.
Stiles	5" x 2"	
Stop	2" x $\frac{1}{2}$"	

Wind Mould, $\frac{3}{4}$" quarter round.

Frame secured to wall with 7" x $\frac{3}{8}$" anchor bolts.

DOORS:

Hang on Butt Hinges, a pair of Framed Ledged Doors, part sheeted, and part glazed with semi-obscured glass, as shown in Fig. 1.

(NOTE: Other suitable types of timber may be specified.)

WINDOW FRAME:

Stiles	4" x 2"	Rebated and throated to detail.
Head	4" x 2"	" " " " "
Sill	5" x 3"	Double weathered, throated and drip grooved.

Wind Mould, $\frac{3}{4}$" quarter round.
Flashing, 26 gauge galvanized iron.

WINDOW SASH:

Sash material of stock sizes.

FRAME JOINTS:

Door and Window Frames mortised, tenoned and painted with Red Lead before nailing together.

Doors and Sashes mortised, tenoned and thoroughly glued before wedging together.

IRONMONGERY:

Door Hinges	4" Butt Hinges.
Bolts	2/10" Tower Bolts.
Lock	Draw Back Rim Lock.
Handle	7" Pull Handle.
Sash Hinges	3" Butt Hinges.
Sash Fastener	Casement Stay and Fastener.

ORDER OF PROCEDURE.

The order of procedure will be as follows :-

1. Lay out footings.
2. Excavate Trenches.
3. Pour Concrete into Trenches and allow to cure.
4. Erect brickwork with Door and Window Frames built into walls.
5. Construct Roof of Rafters and Purlins.
6. Fix Fascia and Barge Boards.
7. Fix Spouting and Cover Roof.
8. Floor is paved with concrete.
9. Hang Doors and Windows and Fix Locks.

ERECTION OF BATTER BOARDS.

"Batter Boards", commonly called "Hurdles", are erected as soon as the building lines have been located on the site. Erect them in pairs, one on each end of a wall line, and with the usual working clearance between them and the foundations.

The top of the hurdle must go square across the thickness of the wall.

Mark along the top with saw kerfs, first the building line, secondly the thickness of the finished wall, and lastly the projection past the wall of the concrete footing, as shown in Fig. 1A.

These dimensions are obtained from the Plans.

On all the saw kerfs, drive nails and bend their heads away from the walls, as shown in Fig. 1B. This assists when attaching the chalk lines to them, and also gives an indication of the direction the line will take. In the simple job in hand, this may seem unnecessary, but it is a point that is worth while on more intricate jobs, and should be practised often.

When all the hurdles are erected, they will surround the foundation area, as shown in Fig. 2.

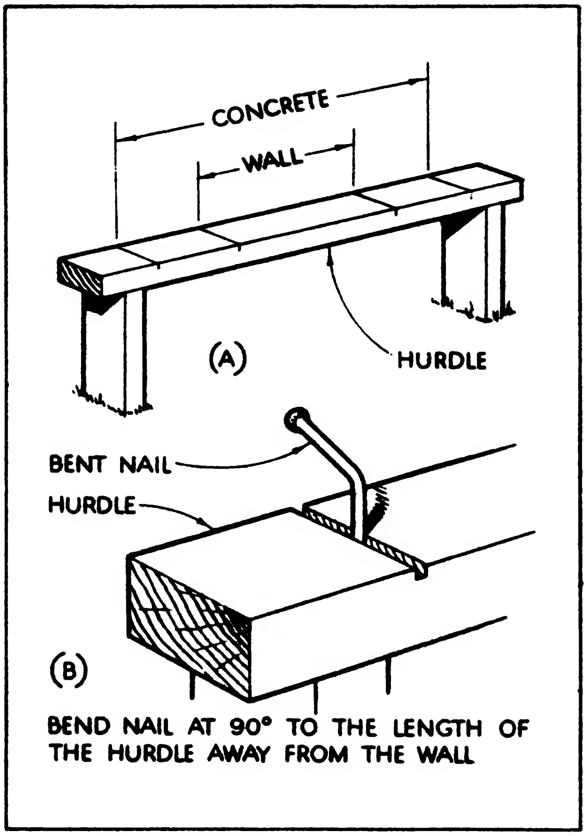


Fig. 1 Erection of a Batter Board.

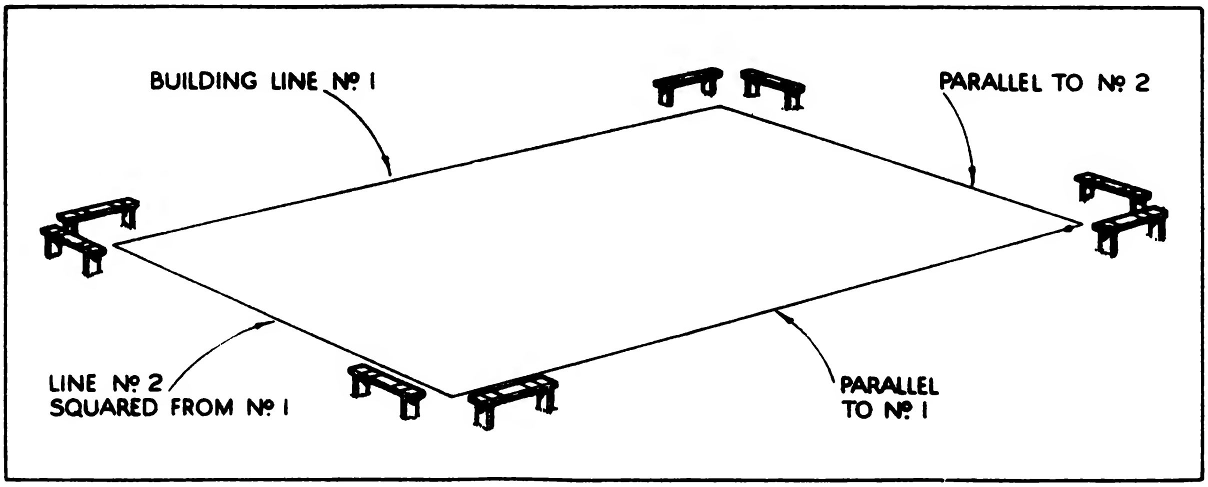


Fig. 2 Erection of Batter Boards Surrounding the Foundation Area.

STAKING THE CONCRETE LEVELS.

Along the ground lines obtained from the "hurdles" the trenches are excavated to the required depth. Steps in the trench bottom and the concrete top are decided by the fall of the land. On a site where the fall of the land is great, the steps in the concrete will require to be made in the height of two or more courses of brickwork. A good excavator can dig a trench with a level bottom and suitable steps in height without much help.

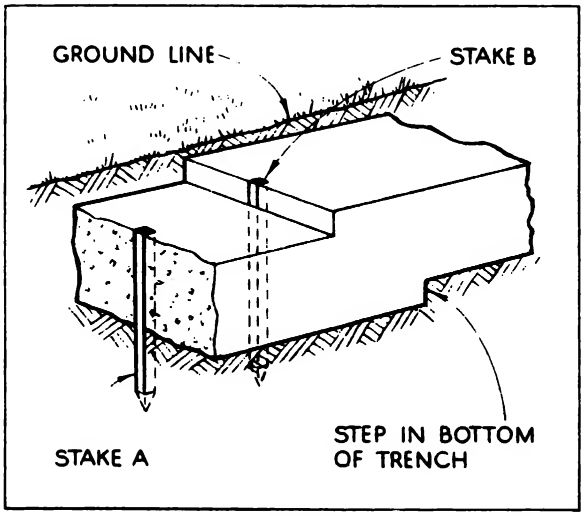


Fig.3 Position of Stakes in Concrete Step.

As soon as the trench is clear the carpenter commences at the lowest corner, and with the aid of a chalk line and measuring stick, or a straight edge and spirit level, checks up the level of the trench bottom and follows that by staking the concrete levels.

The small stakes are driven in the bottom of the trench and left with their tops at the concrete height, The position these stakes occupy is shown by a completed concrete step, as shown in Fig.3. Steps must always rise in height to suit courses of bricks.

POURING THE CONCRETE.

Reinforcing rods are laid in the trenches by the concretor. The rods are supported at the required height by wires of fabricating material.

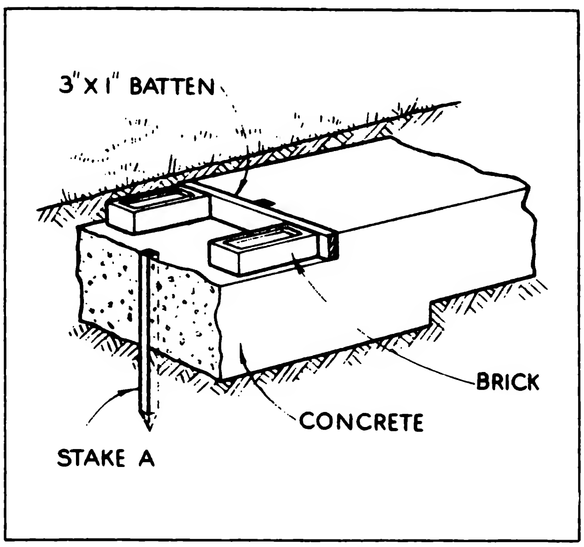


Fig.4 Batten Held in Position by Bricks.

The concrete is mixed in a machine with a revolving container which mixes the ingredients thoroughly together before the concrete is carried in barrows to be poured into the trenches.

Temporary supports are made at each step in the height of the foundation by placing bricks against them, or by using short battens which are held in position against the stake by the weight of several bricks, as shown in Fig.4.

The concrete requires approximately one week to set and cure before the walls are erected.

SOLID WALLS.

Brick walls are built in varying thickness to suit the strengths required and the class of brickwork which is demanded. The thickness of a solid brick wall is made in multiples of the width of a brick, which is approximately $4\frac{1}{2}$". Single thickness of $4\frac{1}{2}$" is commonly used for inside partition walls, and occasionally used for an outside wall which is not important and will not receive adverse comments when dampness shows on its inner side after the outside has been exposed to heavy weather.

The thicknesses of solid walls have common trade sizes, which however, are only nominal. They indicate the number of widths of single bricks which they contain, as shown in Fig. 1, and are spoken of as $4\frac{1}{2}$", 9", 14", and 18" walls.

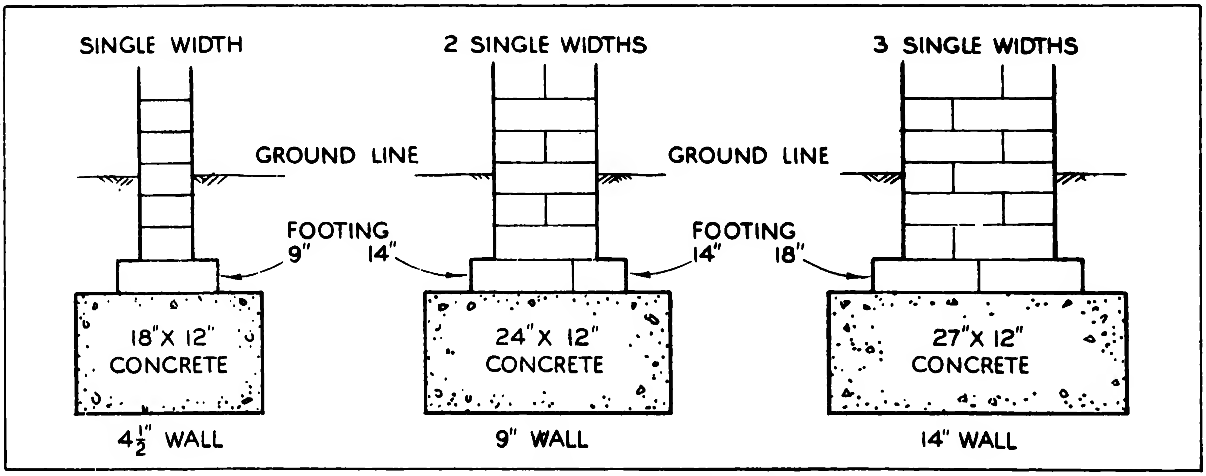


Fig. 1 Thicknesses of Solid Walls.

CAVITY WALLS.

Cavity walls are built with a clear space between the outside $4\frac{1}{2}$" brickwork and the remaining part of the thickness, as shown in Fig. 2. A wide cavity is designed to give the inside part of the wall an insulation from heat and an insurance against dampness. The width of the cavity commonly used in main buildings is $1\frac{1}{2}$" to 3".

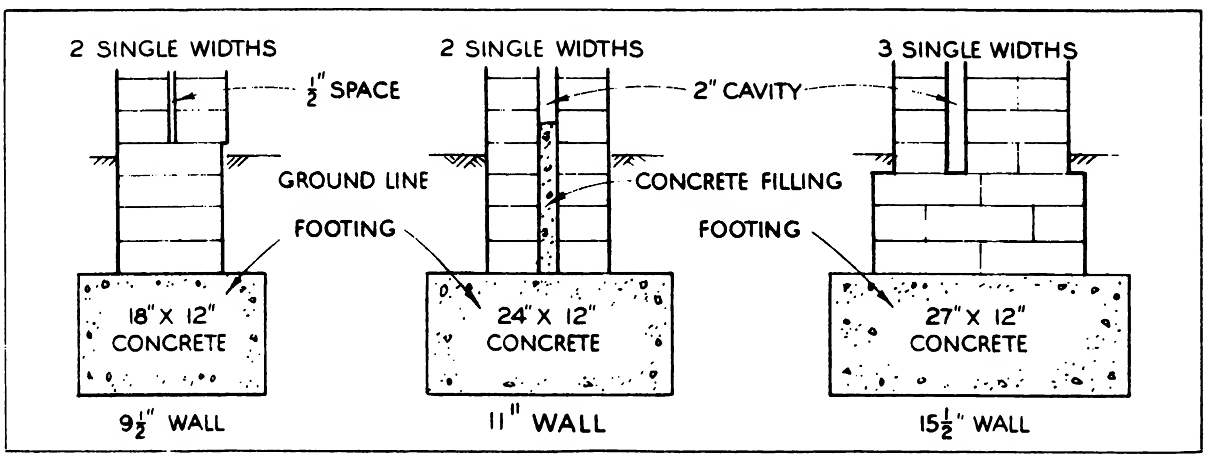


Fig. 2 Thicknesses of Cavity Walls.

GARAGE WALLS.

Garage walls do not have a wide range of thickness and are made as thin as possible to economise material and space. A common thickness is solid 9", and the two $4\frac{1}{2}$" widths of bricks are bonded by the bricks in the third or fourth courses of height being laid with their 9" length across the wall to show their ends, or "heads", along the row. This is what is known as a "course of headers". The outside of the wall is the working face and is finished vertically with good joints. As bricks do not all come from the kiln exactly one standard size, it is not possible to give a 9" wall which is built with a brick bond the same even finish on both inside and outside. The inside surface of the whole wall is generally "bagged down",which means that while the work is still "green" it is rubbed down with thin mortar on a bag and left with a rough sanded finish all over.

In order to allow the inside face to be made as good as the outside face, the wall thickness of 9" is increased by approx. $\frac{1}{2}$". The bonding courses of bricks are then omitted and rows of wire ties are spaced out to take their places. Separating the two widths of bricks gives the bricklayer freedom to build the inside face to a straight line as well as the outside of the wall. It also allows a small cavity for the angle irons of lintels, and more important still, the outside bricks are laid in "stretcher" bond and in more expensive coloured bricks than those on the inside, so that they will match those in an adjacent main building.

PARAPET WALLS.

It must be borne in mind that at door openings where the frames are fixed against the inside of the walls the $9\frac{1}{2}$" work reveals 9" from the outside and the remaining $\frac{1}{2}$" is covered at the frame by a wind mould or cover strip, as shown in Fig.3A. When the wall reaches roof height and a parapet wall is to be formed the $9\frac{1}{2}$" thickness is reduced to 9" as shown in Fig.3B, so that all the bricks can be of the same colour with close end joints where they come into view. The walls of the main building are frequently capped with 9" work, as shown in Fig.3C.

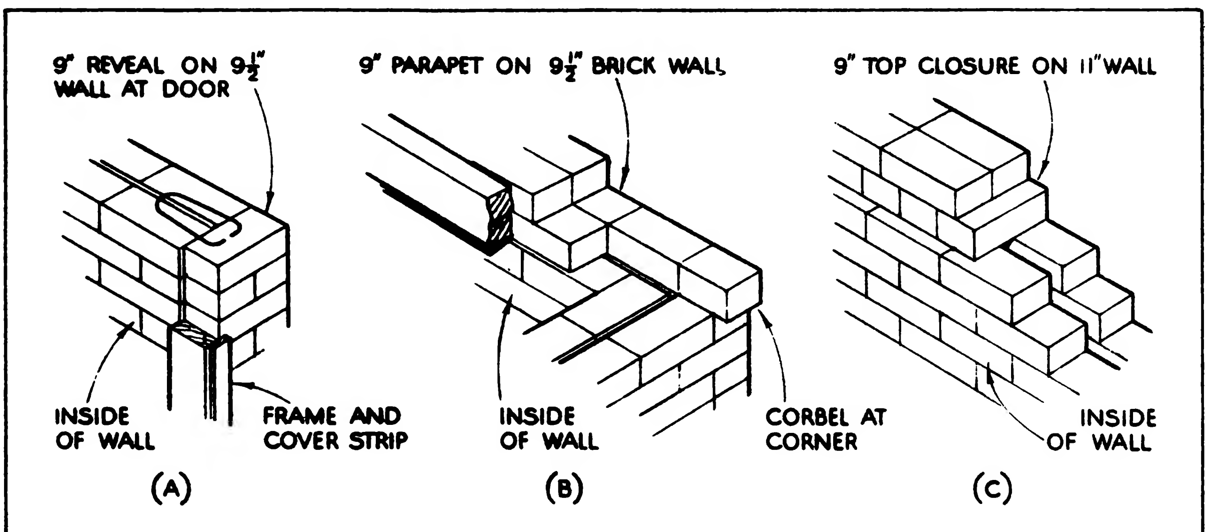


Fig.3 Construction of Parapet Walls.

ERECTING THE WALLS.

The bricklayer will erect the walls on the concrete footing to the lines marked on the hurdle. The work is commenced by laying the number of courses of bricks which will rise over all the steps in the footings, to the top height of the footing and form a datum level for measuring the heights of the walls.

One corner is then carefully built, with a convenient number of courses. The line of the corner is kept plumb and the bricks laid level. The other corners are built next, and then the brickwork between them is filled in by working to a line stretched along the wall from one corner to another.

In order to maintain an even height on each corner, a "storey rod" is required. A big nail or flat bar is built into the wall corners at datum level and allowed to project far enough to support the rod when it is in use.

USING A STOREY ROD.

The "storey rod" is made on a light batten of 2" or $1\frac{1}{2}$" x 1", which is long enough to reach the whole height of the brick wall above the datum level.

The carpenter sets out the rod, marking on one edge the heights for courses of bricks, and on the face the heights of both bottoms and tops of openings for the window and the door frames, as shown in Fig.4.

The marks are made by saw kerfs. Instead of marking every course on the rod, they are frequently marked in groups of four. The standard height of four courses of bricks is "not more than $13\frac{1}{2}$". As bricks from some kilns are thinner than others, the four courses of bricks may be 13". The bedding joint between the bricks should not be more than $\frac{3}{8}$".

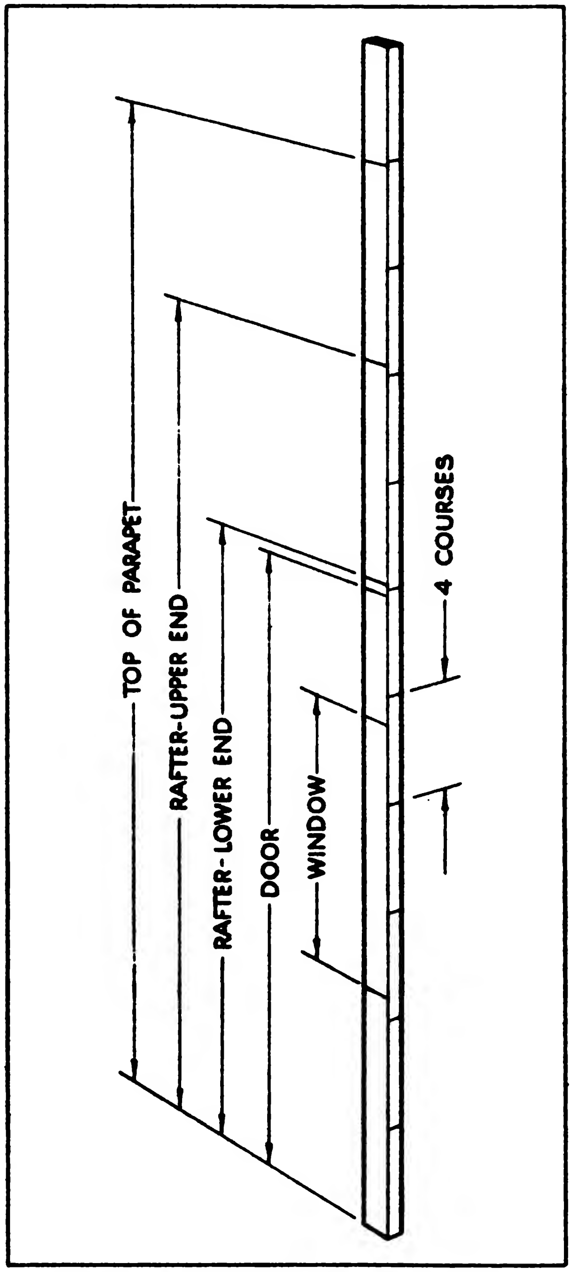


Fig.4 Heights Set Out on Storey Rod.

The heights of door and window frames should be ordered to sizes between courses of bricks, so as to save cutting the thickness of the bricks, either above or below the frames.

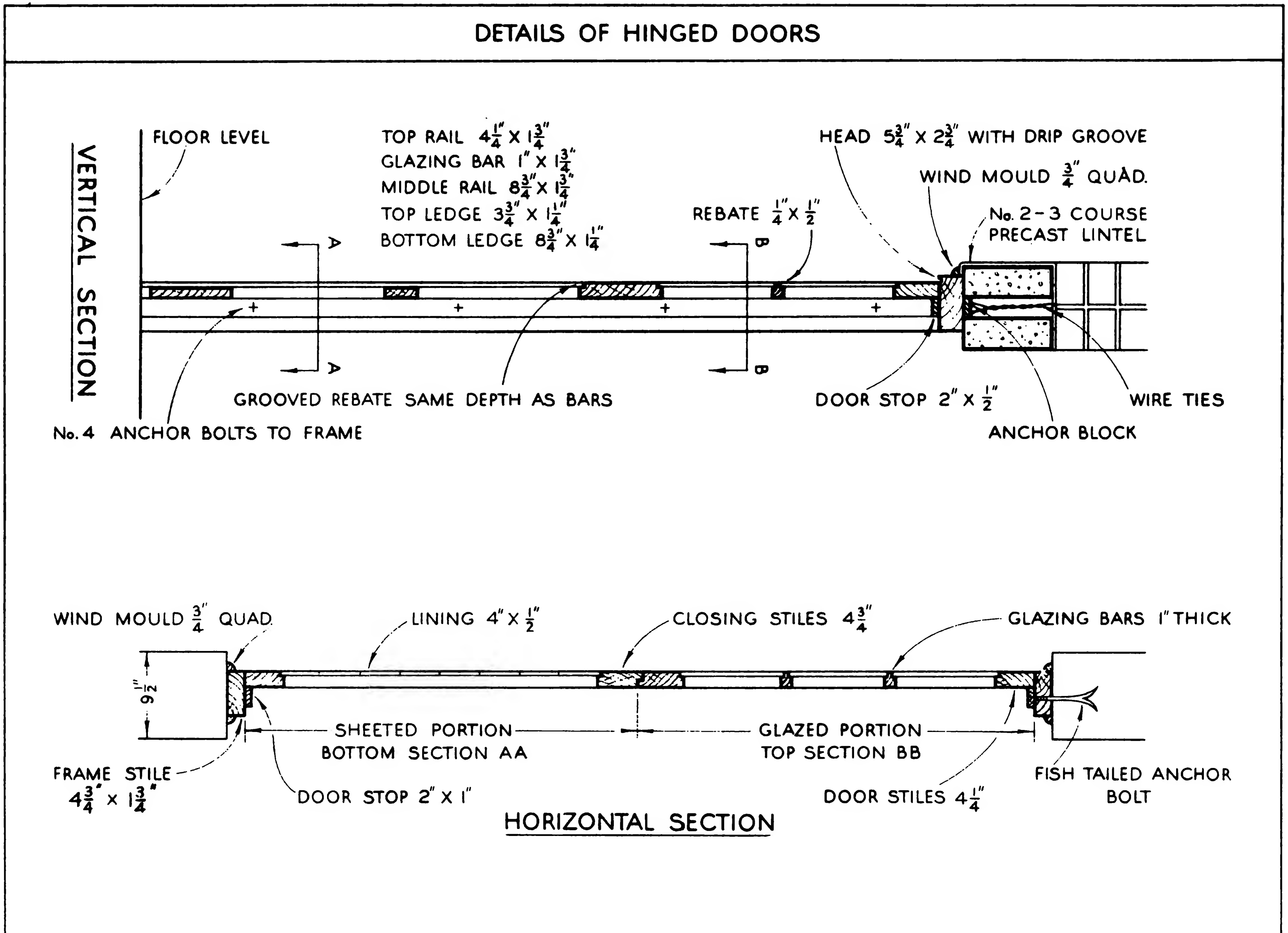


Fig.1 Vertical and Horizontal Sections of Hinged Doors.

SETTING IN THE DOOR FRAME.

The door frame is complete when delivered on the job from the joiner's shop, and is erected as soon as the brickwork is high enough to hold the frame in its place along the length of the wall. The position of the door frame in the wall is shown in Fig. 1.

Before erection, all the holes for the bolts and ties are bored through the frame. The stiles are set out from the storey rod, with centres of holes for anchor bolts. The holes are spaced with one in the second brick joint from the bottom, another in the second joint from the top, and two others spaced between them. All holes must be directly in line with the bedding joints of the bricks. The bolts are made in several shapes. A common form of bolt is shown in Fig. 2.

The frame is plumbed up with a plumb rule or spirit level, and two braces are fixed from the head to the ground pegs, as shown in Fig. 3. The braces are placed as far apart as possible, and care is taken to see that the frame has no twist. A check is also made with a straight edge and level to ensure that the head is level.

Wire ties are necessary to hold the head tightly against the underside of the lintels. The wires are inserted through the holes in the head and will later be passed through the cavity between the two concrete lintels and tied to a cross rod above them, as shown in Fig. 4.

When the brickwork is completed and the mortar has set thoroughly, the nuts of the anchor bolts are tightened, and the wind moulds are nailed to the frame, after the pair of doors has been hung.

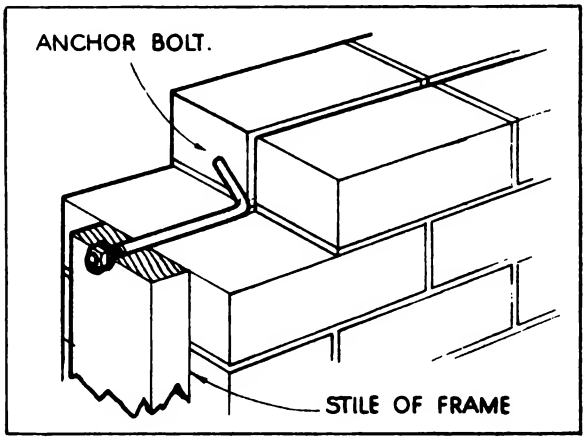


Fig. 2 Method of Inserting Anchor Bolt in Frame.

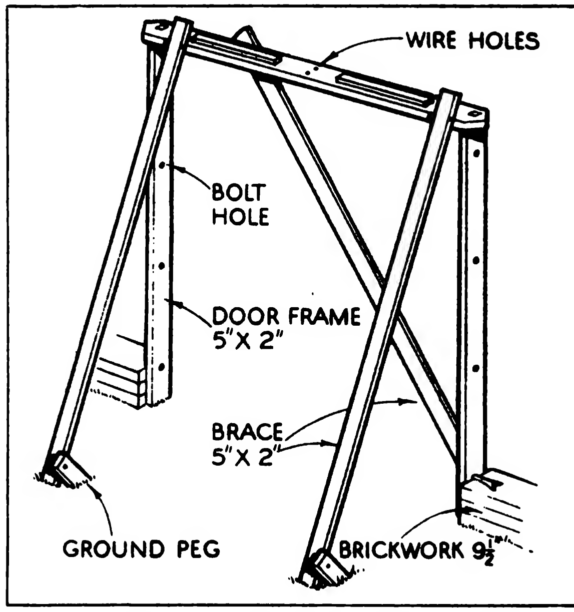


Fig. 3 Method of Bracing the Door Frame.

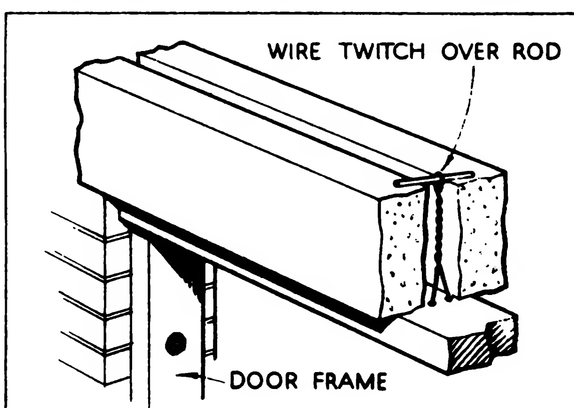


Fig. 4 Use of Wire Ties to Hold Head of Frame.

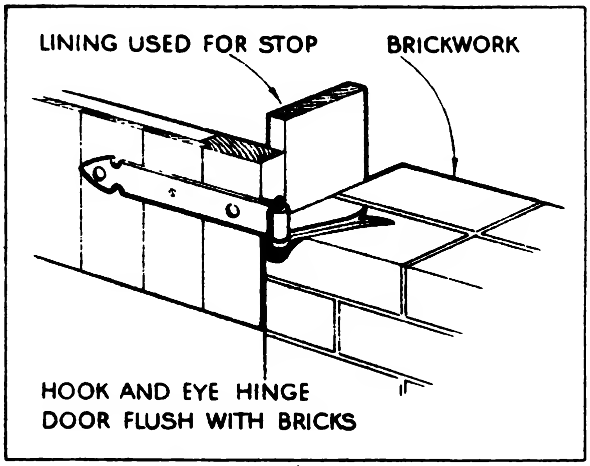


Fig.5 Method of Setting in Door Hooks.

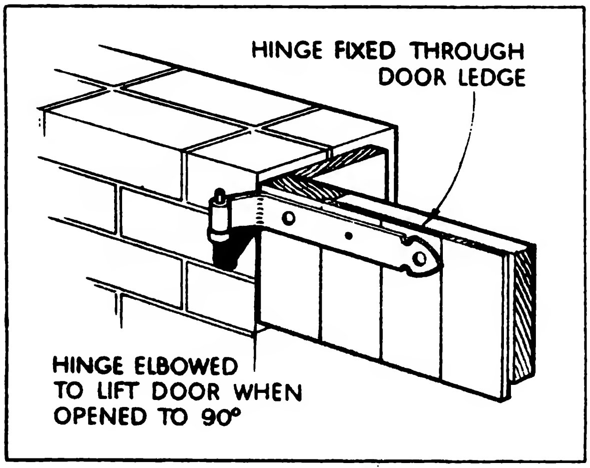


Fig.6 Use of Elbow in Hinge.

SETTING IN DOOR HOOKS.

The detail drawing shows the door hanging inside the wooden door frame on butt hinges. An alternative is for the doors to fit against the brickwork and the inside of the doors to stop close against a jamb fixed as shown in Fig.5.

This allows the hook of the hinges, often referred to as a "gudgeon", being set in the brick-work in a line which is not vertical and therefore not parallel with the edge of the brick opening.

When the door is opened around this centre line to the full 180°, the outside point of the door is raised off level, in proportion to the amount of set the hinge line is given.

This is frequently necessary where the ground at the door slopes across the building.

Where the slope of the ground or path is downwards towards the building, the centre line of the hinges is made out of parallel with the face of the wall, and involves the making of an elbow in the hinge, as shown in Fig.6.

SETTING IN THE WINDOW FRAME.

The window frame is set with its metal flashing under its sill to rest on a bed of mortar. Like the door frame, it is plumbed up, levelled and temporarily held in position by braces nailed to ground pegs until the brickwork holds it. Do not remove the joiner's cross braces before they are of no further use.

Great care must be taken when setting the frame to see that there is no twist between the two stiles. Check them by a "boning" sight after the braces have been nailed on.

The frame is fixed in the wall by the brickwork being cut to fit around cleats nailed to the outside of the stiles and the projecting horns at the ends of the head. There are alternative positions in the thickness of the wall where window frames can be built and a detail drawing such as Fig.7, shows the place that the designer wishes it to be built in this garage.

The lintels that bridge over the brick opening should rest wholly on the brickwork and leave at least $\frac{3}{8}$" clearance above the timber frame.

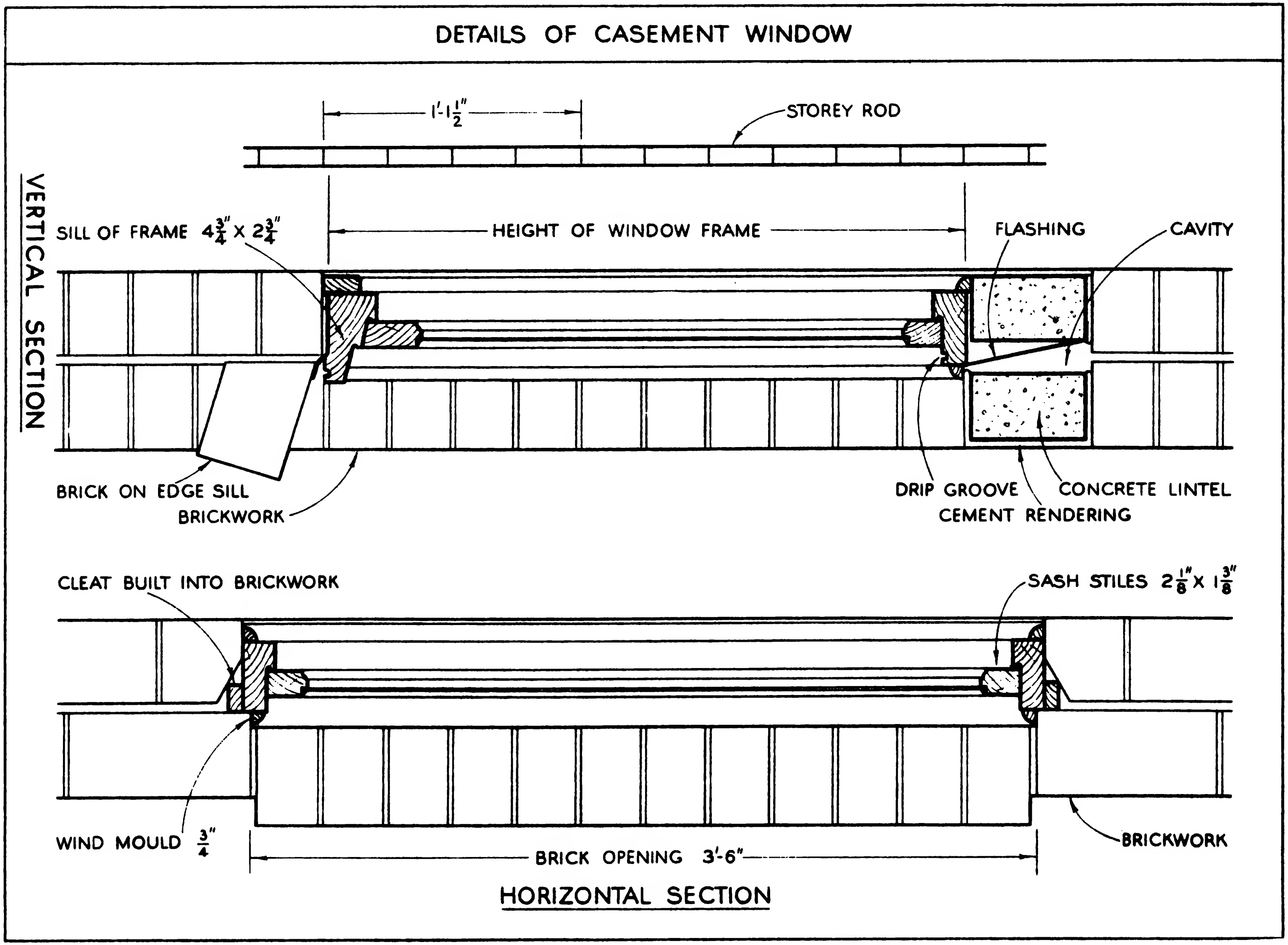


Fig.7 Vertical and Horizontal Section of Casement Window.

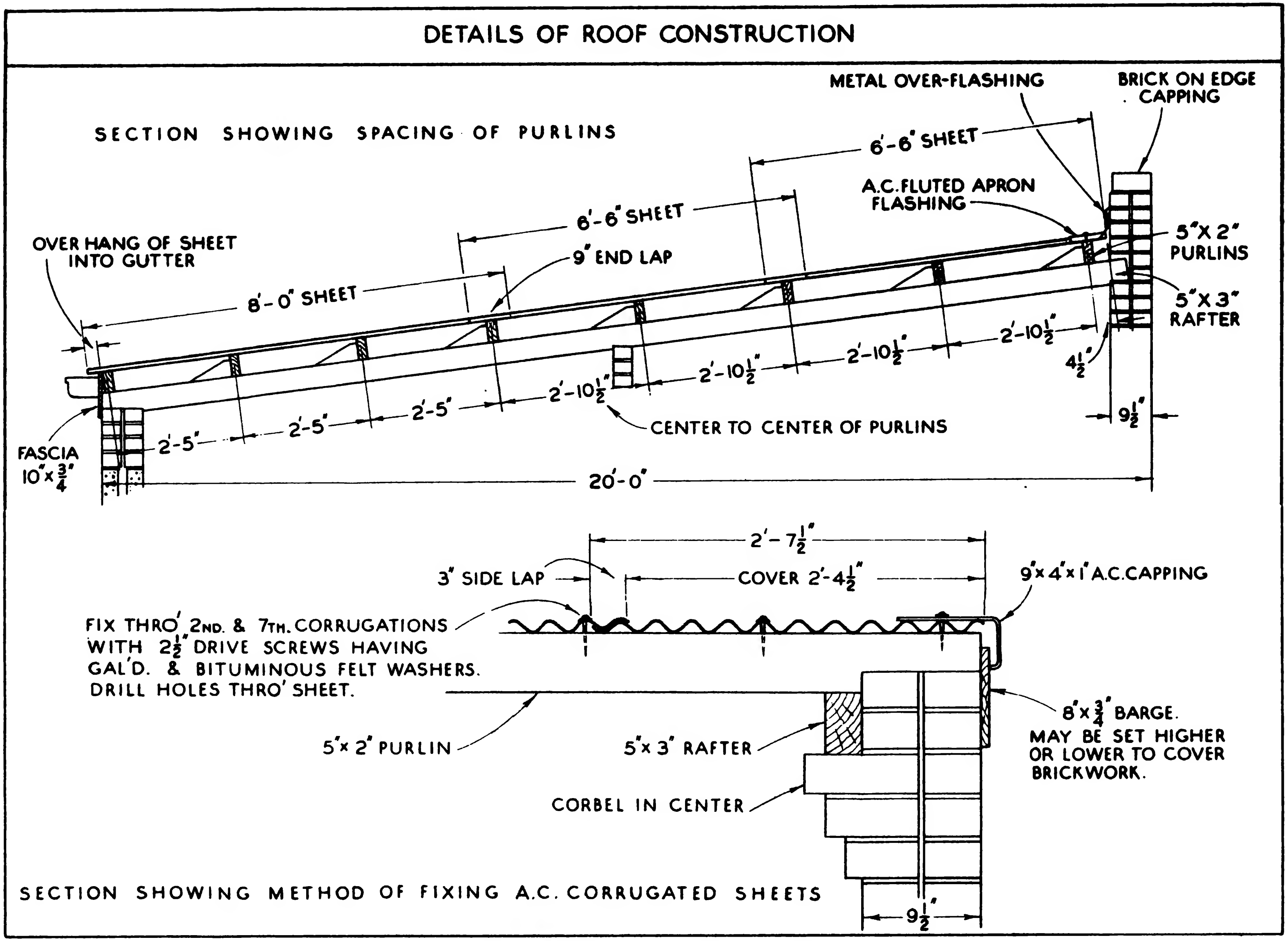


Fig.1 Method of Construction of Roof.

ERECTING THE ROOF.

Roofs that are constructed to cover, with only one slope, a whole building, are known as skillion roofs. The slope is usually of a low pitch. These roofs are frequently bounded by parapet walls, and are commonly referred to as "lean to" roofs. The waterproof covering is either fixed to battens on rafters spaced at 3' centres, or on purlins supported at wider intervals of approximately 10 ft.

Details of the roof construction for this garage are shown in Fig. 1. As the rafters are widely spaced and few in number, they do not require a pattern to be set out for repetition. When the walls reach the necessary heights the rafters are laid on the brickwork and their bottom edges scribed to the brickwork far enough down to give level bedding junction cuts, as shown in Fig. 2.

Purlins are spaced out along the rafters to suit the lengths and overlapping ends of the sheets. Intermediate purlins are spaced out at not more than 3' centres. Space the purlins to the middle of the lap to avoid faulty construction such as shown in Fig. 3.

It should be noticed that an end lap of approximately 9" is given to the sheets. On a steeper pitched roof this lap may be reduced to 6".

The purlins are gauged at their ends to make a straight top line and are skew nailed to the tops of the rafters against blocks that keep them at 90° to the rafters.

A position occurs around the short parapet which requires a short trimmer between the purlins, as shown in Fig. 4, to provide fixing for the roof covering where it is cut shorter than full length.

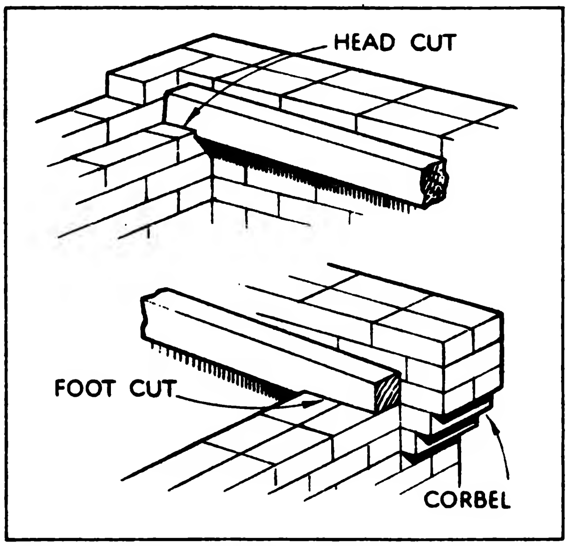


Fig. 2 Method of Fitting Rafter to Brickwork.

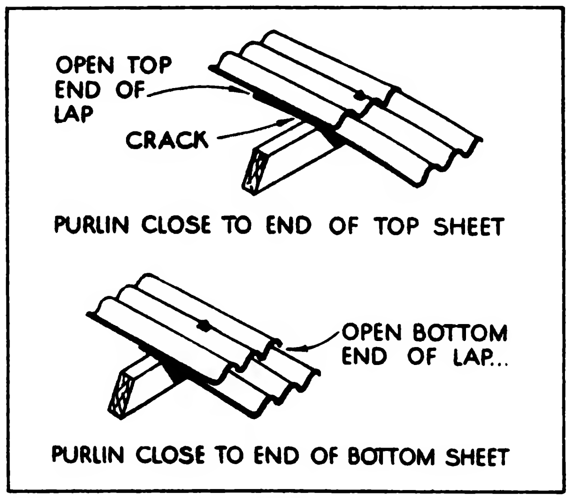


Fig. 3 Effects of Incorrect Spacing of Purlins.

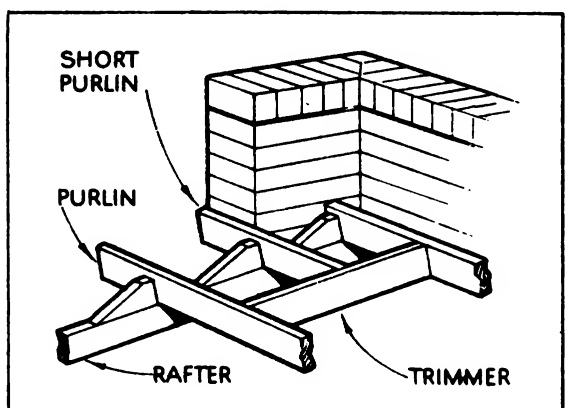


Fig. 4 Trimmer Fitted Between Purlins.

FIXING FASCIA AND BARGE BOARD.

The fascia covers the junction of the roof timber and the brickwork, and becomes a fixing piece for the spouting. It is fixed to the lowest purlin and to the feet of the rafters. Intermediate short blocks of 5" x 3", spaced out at approximately 18" apart, are nailed on the underneath side of the purlin to make the good fixing above the brickwork that this wide board requires.

The barge board is nailed to the ends of the purlins and covers the junction between them and the brickwork of the wall. The top edge of the board and the outside edges of the corrugated sheets are covered later on with a fibro cement mould that makes their junction weatherproof.

FIXING CORRUGATED ASBESTOS CEMENT SHEETING.

In fixing corrugated asbestos cement sheeting consideration must be given to the thickness of the sheets, which are much thicker than corrugated iron. The overlapping corner where four sheets meet would be too thick unless mitre cuts were made at the junction of the middle sheets. The method of lapping four sheets at a corner is shown in Fig.5, as follows:-

A. Sheet No.1 has a square top right hand corner and Sheet No.2 has a mitre cut on the bottom right hand corner, and is fastened over Sheet No.1.
B. Sheet No.3 has a mitre cut on the top left hand corner which enables it to be fitted without an overlap up against the mitred corner of Sheet No.2
C. Sheet No.4 has a square bottom left hand corner which covers the mitre joint between Sheets Nos. 2 and 3.

The positions of the mitred cuts necessary are shown in Fig.6.

Commence covering the roof by fixing the first sheet in the bottom row with an overhang of 2" into the spouting to provide a drip for rainwater. Follow up the slope with the second sheet which must have the bottom right hand corner mitred, then with a sheet similarly cut for the row higher up.

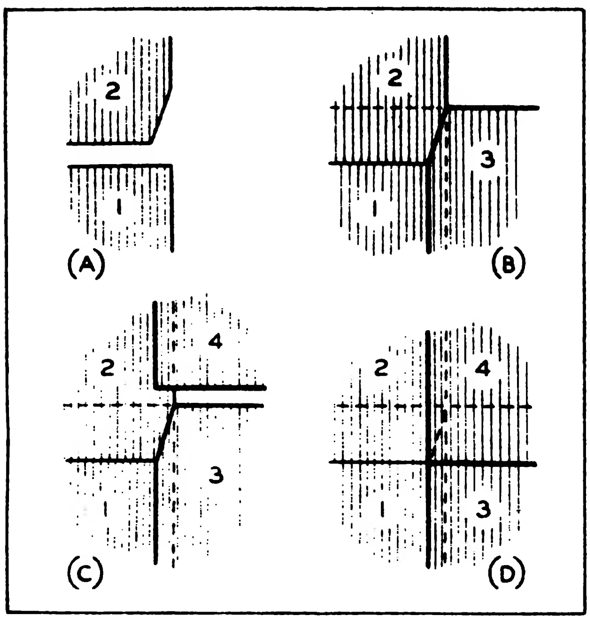


Fig.5 Method of Lapping Sheets at a Corner.

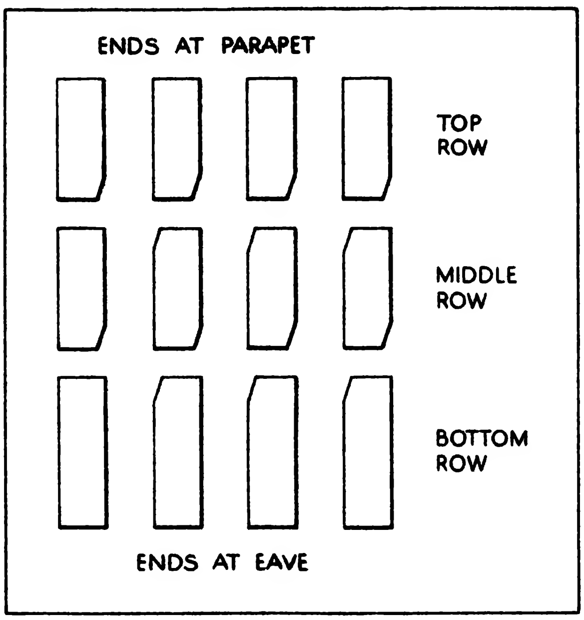


Fig.6 Positions of Mitred Cuts.

HANGING THE WINDOW SASH.

Specification: Sash hinged at the top to open outwards.

The sash is fitted into the frame in the usual way. The amount of clearance that should be given between the sash and the frame is often referred to as "the thickness of a penny". Where the sash opens to the weather side a little more clearance should be made to allow for the swelling of the timber due to rain.

The proportions of height and width of sash generally indicate the way it should be hung. A sash that is shorter than it is wide is better hinged at the top or bottom rather than at the side.

The hinges are housed and screwed into the top rail at a distance of approximately 2" away from the stiles in the same way as those described for a casement sash.

Hanging the sash on its top rail becomes difficult when the stage is reached where the hinges are ready for screwing to the frame.

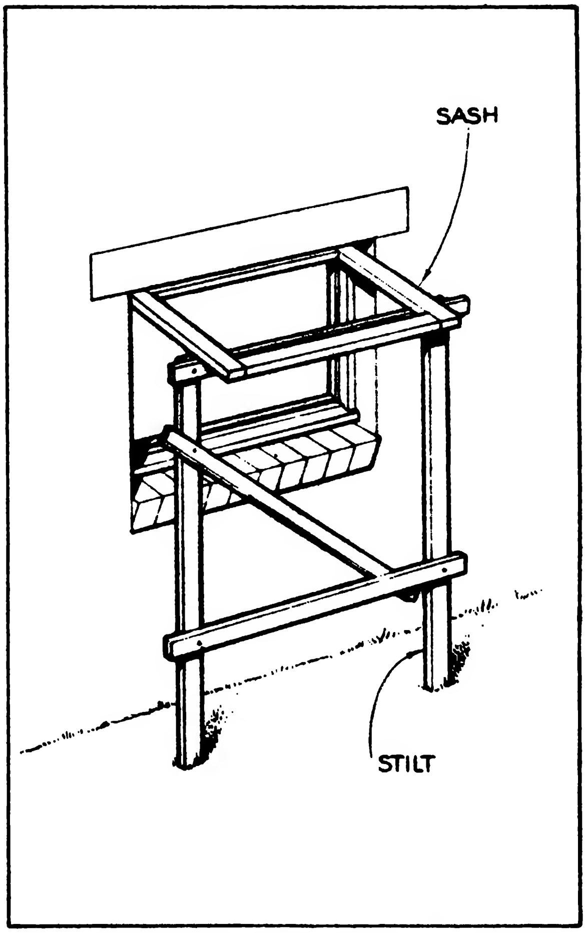


Fig.1 Use of Stilt for Supporting Window Sash.

When the operation is being carried out single handed, and a plank on step ladders is not available, a stilt should be made, as shown in Fig. 1, to carry the weight of the sash and allow the use of both hands when directing hinges and screws into the frame.

HANGING THE DOORS.

The doors are fitted and hung with butt hinges in the usual way :-

(i) Check the sizes of the doors with the opening in the frame.

(ii) Reduce the overall size of doors very closely to the size of the opening in the frame.

(iii) Erect the doors against the outside of the frame.

(iv) Scribe the neat finished size on the doors from the frame and fit them to the frame.

(v) House the hinges into the doors and frame, and screw the hinges to the doors.

(vi) Screw hinges lightly to the frame, test the fit of the doors, and if all correct, screw tight.

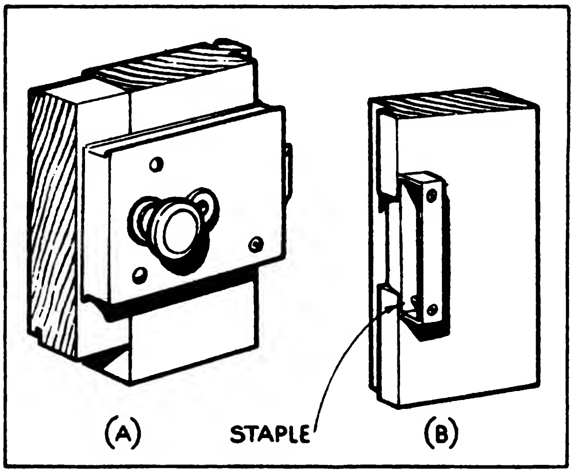


Fig.1 Rim Lock for Door.

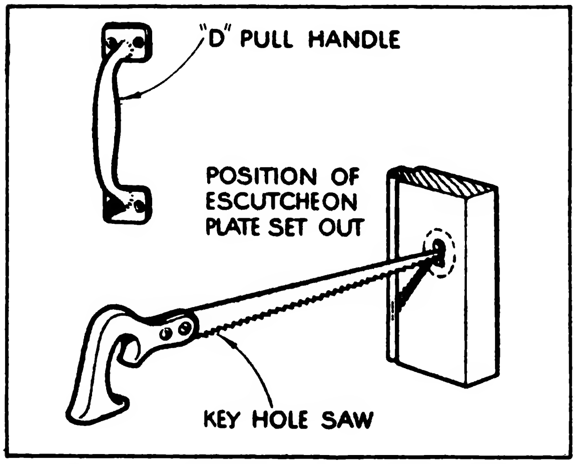


Fig.2 Door Handle and Escutcheon Plate.

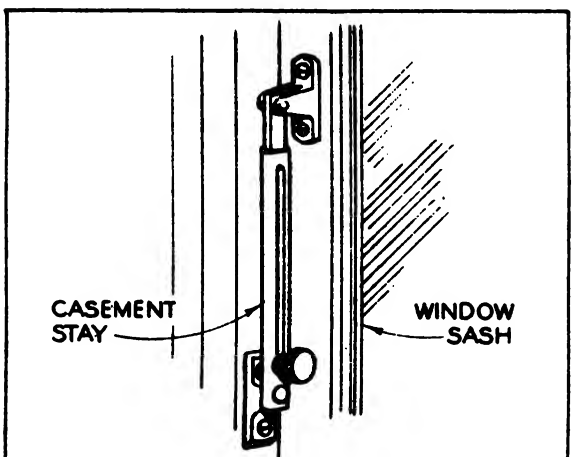


Fig.3 Method of Fitting Window Stay.

FIXING THE DOOR LOCK.

The door lock which is specified in addition to the usual tower bolts, is a Rim Lock with a draw back bolt, as shown in Fig. 1A. This type of lock is adaptable for use on either a right hand or left hand door.

Scribe the back projecting plate of the lock on the edge of the first door and house it flush before marking the centre of the keyhole.

This centre is located by first squaring the vertical centre line of the hole across the back of the lock and after marking it on top of the lock, transfer it to the door.

Gauge down parallel with the edge of the door to the correct height and bore squarely through the door holes with sizes in keeping with the opening in the escutcheon plate, and cut to shape from the face of the door with a keyhole saw, as shown in Fig. 2.

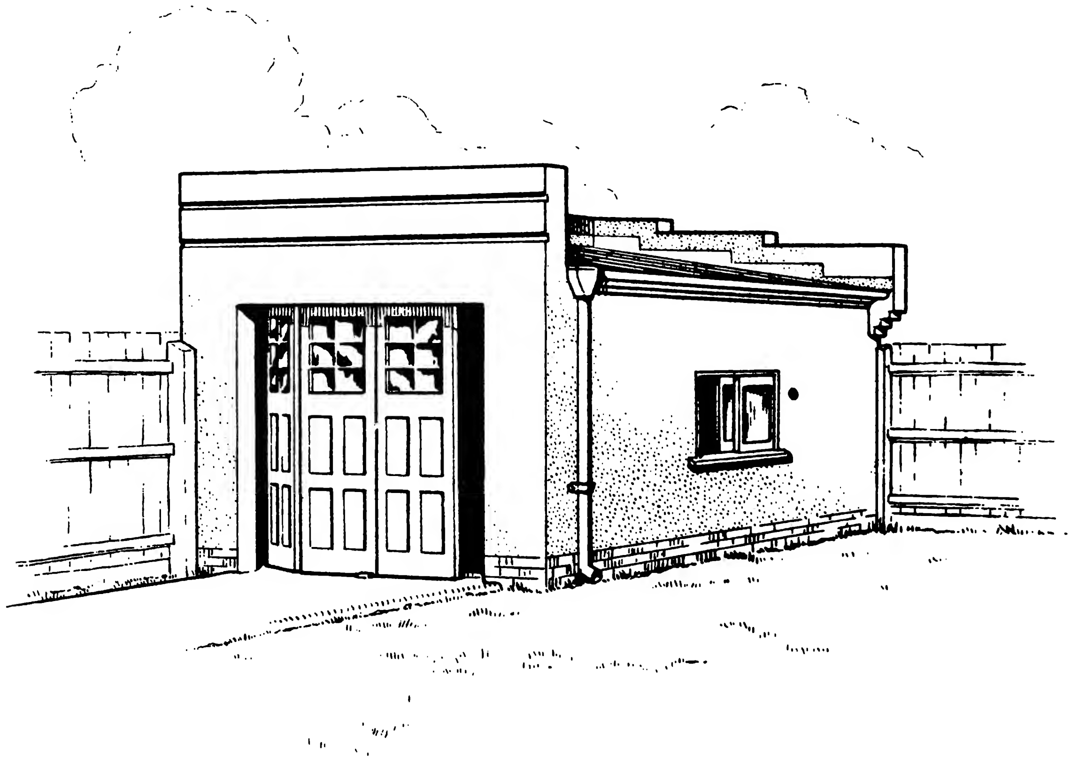
Screw the lock in place before marking from the staple the part of the rebate to cut from the second door of the pair, as shown in Fig. 1B.

FIXING THE DOOR HANDLE.

The "D" Pull Handle, as shown in Fig. 2, is screwed on the outside of the door to give assistance in opening the door when the key has been turned.

FIXING THE WINDOW STAY.

The casement stay, which holds the window open in any desired position, is attached to the window sash with screws, as shown in Fig. 3 in as low a position as possible. A short barrel bolt is required to hold the sash tightly shut against the rebate of the sill when it is closed.



PICTORIAL VIEW OF GARAGE

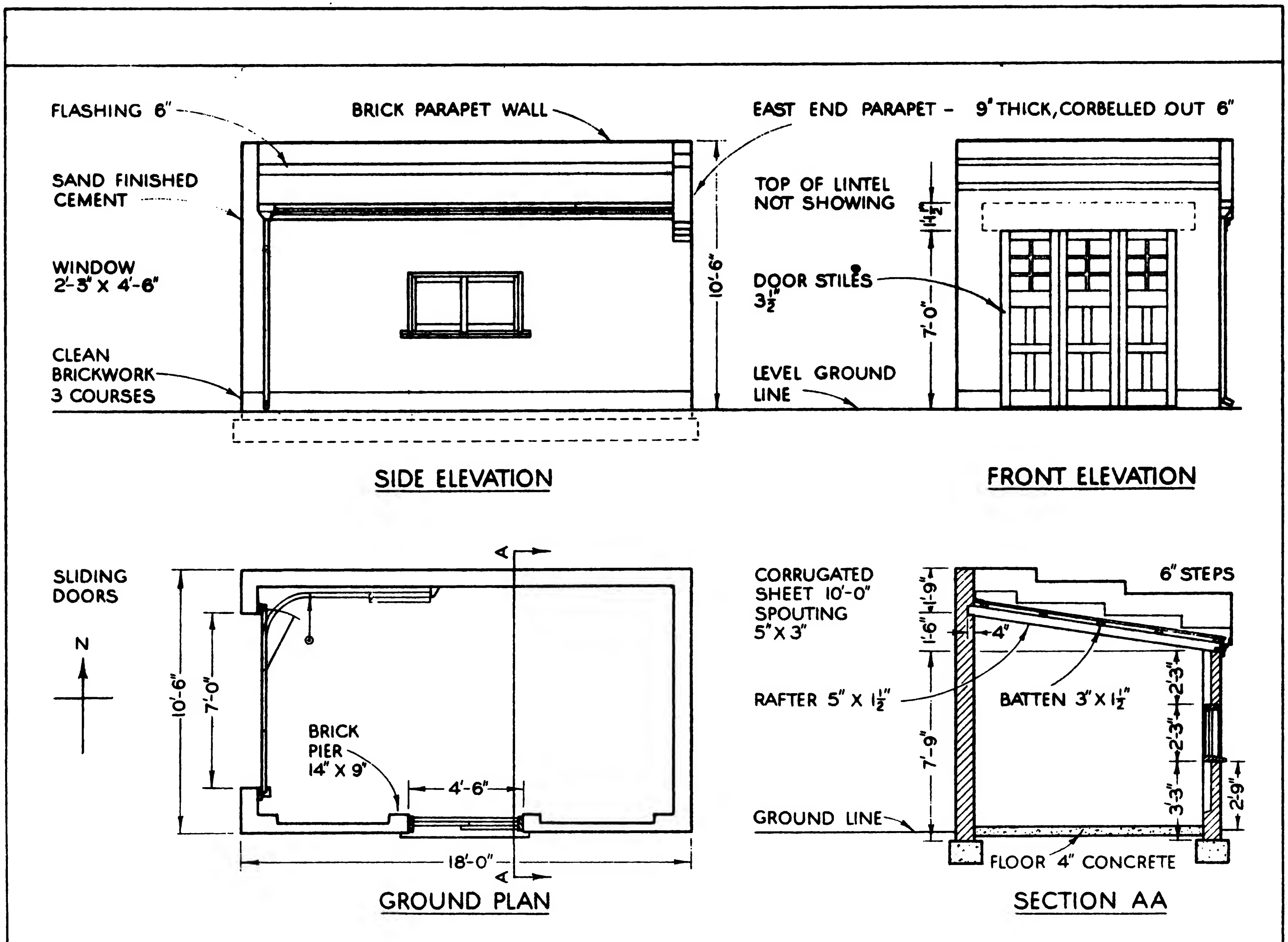


Fig.1 Plan of the Garage.

GENERAL SPECIFICATION.

The garage is a detached brick building, and has a lean to roof covered with corrugated asbestos cement sheets. It is to be erected to the following specifications, and to the dimensions shown in the accompanying plans and detail drawings.

SPECIFICATION OF MATERIALS.

FOOTING:

Concrete footing to all walls, 12" deep and 18" wide.

WALLS:

Brickwork, 9½" thickness, on the East, North and West walls.

The South Wall has 9½" footing and has panels of ½-brick thickness between 14" piers, as shown in plan. The exterior of all walls and all parapets must be rendered in cement with fine sanded finish of a selected colour. The cement rendering commences at the third joint above the ground level as shown in plans.

Damp Course, of approved waterproofing material, must be laid at the bottom of all walls and tops of all parapets.

Lintel of Door Opening to be formed in timber, reinforced with metal rods and poured in concrete.

Lintel of Window Opening to be 3" x 3" angle iron.

ROOF:

Wall Plate	4" x 1½"	Hardwood.
Rafters	5" x 1½"	Hardwood, at 3' centres.
Battens	3" x 1½"	Hardwood, at 3' centres.
Fascia	8" x ¾"	Oregon, dressed.
Moulding	2" x 1½"	Ovolo, under spouting.

Roof Covering, corrugated asbestos cement sheets of standard pattern.
Flashing of Parapet Walls, asbestos cement apron and over flashing.

DOOR FRAME:

Stiles	4" x 2"	Fixed to wood plugs in brickwork.
Stops	3½" x 1½"	Planted on stiles.
Head	6" x 1¼"	Screwed to metal plugs.
Track Board	6" x 1¼"	Screwed to wood plugs.

Floor Guides of kidney shape set in concrete floor.
Sliding Door Track and Hangers of approved make.

DOORS:

Triple Doors are hung on Barn Door Sheaves to slide on angle rail track as shown in detail drawing. One door must be hinged to open as shown and fitted with Rim Night Latch. Three pull handles on the set of doors.

WINDOW FRAME:

Stiles	5" x 2"	Grooved for Parting Head.
Head	5" x 2"	Grooved for Parting Head and Rain Drip.
Sill	8" x 3"	Shaped to detail.

Wind Mould, $\frac{3}{4}$" quarter round.
Cover Strips, 2" x $\frac{5}{8}$", dressed and chamfered.
Flashing, 26 gauge galvanized iron.
Staff Beads, $\frac{3}{8}$" thickness.

Window Frames are fitted with special "noiseless track" to allow the inside sash to slide horizontally. Fix the outside sash to the frame as shown in detail drawing. Fit 3" Nickel Flush Pulls to both stiles of sliding sash and lock the sash with No.1 3" Barrel Bolt.

ORDER OF PROCEDURE.

The order of procedure will be as follows :-

1. Footing is built.
2. Brickwork is erected and Window Frame "built in".
3. Timber Box is formed for concrete lintel over door opening.
4. Roof is constructed.
5. Roof is prepared for covering.
6. Spouting, corrugated sheets, flashing and downpipes are fixed.
7. Door Frame and track are fixed.
8. Windows and Doors are fitted and locks are fixed.
9. Floor is paved with concrete and floor guides set in line of doors.

(NOTE: Other suitable types of timber may be specified.)

PREPARING THE WINDOW FRAME.

Prepare the window frame for building into the brickwork. It requires cutting to fit neatly around the brickwork. Cleats must be nailed on the backs of the stiles at heights that agree with the courses of bricks. The head must be cut at both ends with a bevel that will dovetail it into the brickwork.

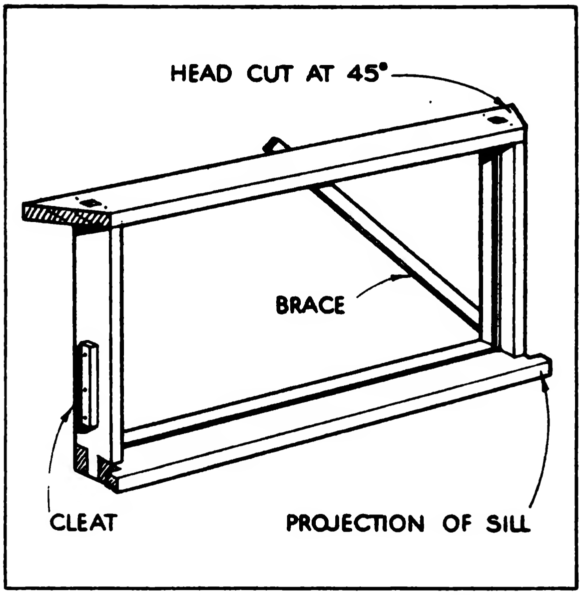


Fig.1 Window Frame ready for Fixing.

The stop bead of the sill is temporarily fixed on the underside of the head where it will be less liable to damage than on the sill.

The sill has a groove for the insertion of a running track and should be protected from becoming choked up with mortar by tacking a piece of scrap material over it.

The cuts and cleats on the frame are shown in Fig. 1.

Weep holes are bored through the sill by the joiner when making the frame. Clear drainage channels to the outside of the wall must be made on the underside of the sill above the flashing. These may be chiselled out in the direction shown in Fig. 2.

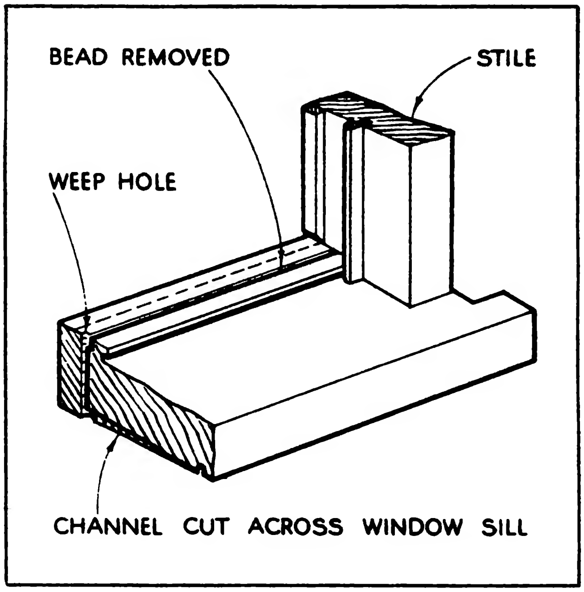


Fig.2 Section of Sill Showing Weep Holes.

SETTING IN THE SASH FRAME.

Set in the sash frame as soon as the brickwork is high enough to take the frame, making sure that the flashing is under the sill.

For sliding sashes it is most important that the frame has a straight, level sill, and that the head is parallel. The stiles must be plumb. Use a spirit level for testing both the face and the edge of the stile and brace the frame accurately in position without a twist.

The height of the frame is made to seat the sill on a regular course of bricks, and its head clear of the angle iron lintel that carries the weight of the brickwork over the window.

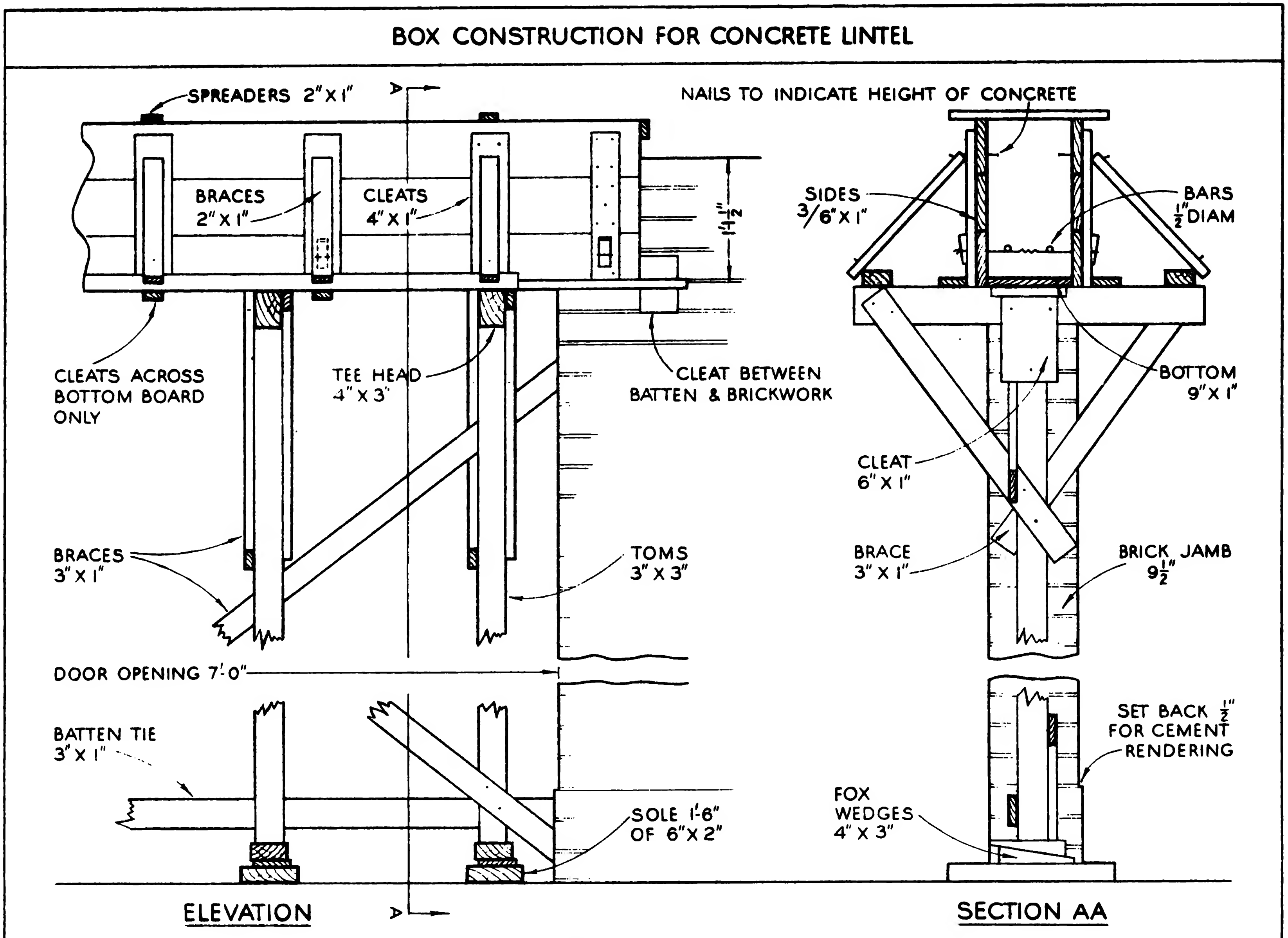


Fig.1 Timber Boxing of Lintels.

TIMBER BOXING OF LINTEL.

Box up a form for the concrete lintel over the door opening when that height is reached by the bricklayer. The shape of the whole box is shown in the detail drawing in Fig. 1.

The timber box is temporary and must be constructed and supported so that it can be easily stripped off when the concrete is set. The sides of the box are generally removed first, in order to allow quicker drying of the concrete. The supporting toms and the bottom of the box are left for a longer time to prevent any load straining the concrete before it is sufficiently cured to take the stress. The time required would not be less than 7 days, and it might require to be lengthened to suit the prevailing circumstances.

In order to facilitate the work of erection, some parts of the box will be prepared beforehand by nailing the cleats across the boards and stacking the parts in readiness for assembly.

The fox wedges will also be cut from first class material, approximately 8 inches long and not less than 3 inches wide. They must be well sawn to a common pattern, such as shown in Fig. 2. Wedges that are cut with an axe to varying tapering thicknesses are not satisfactory.

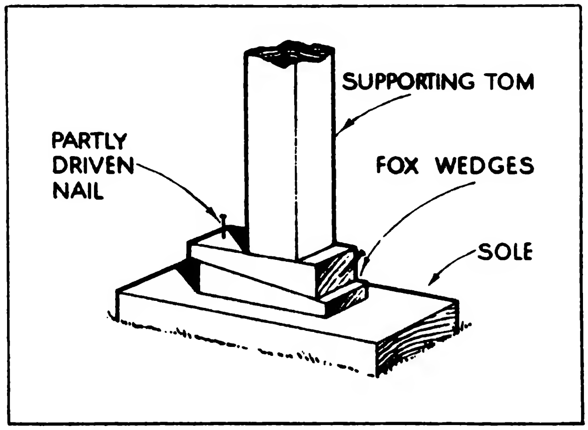


Fig. 2 Use of Fox Wedges under Toms.

It will be noticed that the thin ends of the wedges are not feather ends but are more than half an inch in thickness. This thickness is necessary so that they can take the blows which will be given to them when they are being removed. The wedges are fixed together in pairs and to the soles by partly driven nails, as shown in Fig. 2.

The tee heads of the toms are constructed with cleats and braces that secure the head square to the length of the tom. The heads must be long enough to provide bracing from them to the sides of the box at a good angle.

Erection of the box is commenced by first laying the soles, with wedges attached, on firm ground, at positions spaced out at approximately 2 feet centres along the centre line of the door opening.

A chalk line is stretched across the soffit line of the lintel so that measurements of height can be taken from it. The line makes the height of the bottom of the box. The toms are cut to fit between the wedges and the box, and are braced up in position to receive the boxing that has been already prepared. The tee heads of the toms form the bases for bracing the sides of the box.

Wedges are preferable to nails for making the sides tight against the bottom as they can be removed with less chance of fracturing the lintel when stripping. Spreaders and wire ties are utilised wherever a strain is not supported by an outside brace.

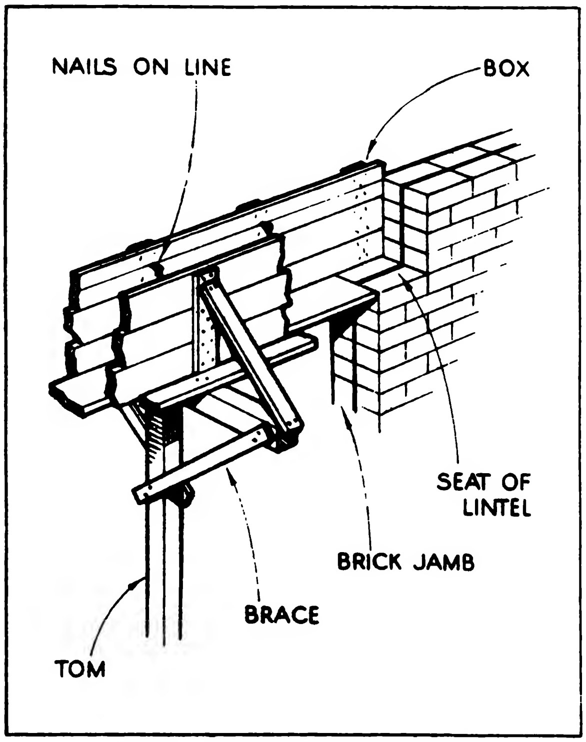


Fig.3 Junction of Box and Wall.

The box is made at least $\frac{1}{4}$" less in thickness than the brickwork so that should its face line swell out of shape by dampness when the concrete is poured, its facing coat can be ruled straight during the following operations by the plasterer.

The junction of the box and the wall is shown in Fig.3. A chalk line is used to mark on the inside of the erected box the top line of the finished concrete. Part driven nails are spaced out along the length of the side to indelibly mark this line.

The box must be securely braced in position and care taken to insert any reinforcing rods or wires before the top is bridged by nailing on spreaders. The top should be left as open as possible to permit the easy pouring of the concrete.

When the drying conditions are not too severe the sides of the box may be removed as soon as the concrete sets, but as the toms do not interfere with the progress of the surrounding work and the concrete needs a much longer time than is apparent to gain its full strength, these do not have the wedges driven from their feet until the latest possible moment. When that time arrives, carefully strip the remaining timber from the lintel

CUTTING THE RAFTERS.

The wall plate, of 4" x $1\frac{1}{2}$", is cut to the length between the end walls, i.e., 18' minus the thickness of the two parapet walls. The rafters are spaced out along the plate as uniformly as possible, at not more than 3' centres, but they require placing to suit the perpendicular joints between the bricks in the northern wall, where they will be "built in". The number of rafters required is calculated as shown in Fig. 1.

A pattern rafter of 5" x $1\frac{1}{2}$" is cut to the pitch that is measured over the span, and to a rise stepped up in brick courses. The shapes of the cuts are shown in Fig. 2 and Fig. 3. The remaining number of rafters is cut to the pattern.

Fix the rafter feet to the wall plate by skew-nailing as shown in Fig. 2. Where the heads are seated in brick cavities see that they have a ventilation space alongside them as shown in Fig. 3. This protects the timber from deterioration caused through lack of air, and by dampness from close contact with bricks and mortar.

PREPARING FOR THE ROOFER.

Fix the roofing battens by well nailing them to the rafters at not more than 3 feet centres.

Fix the fascia by nailing it to the feet of the rafters and to the wall plate. The top edge of the fascia must be made to line up with the face of the battens.

Spouting mould must have its top edge cut to fit around lapped joints of spouting and its length fixed with a fall of not less than $\frac{1}{2}$" in 10" towards the rain water head.

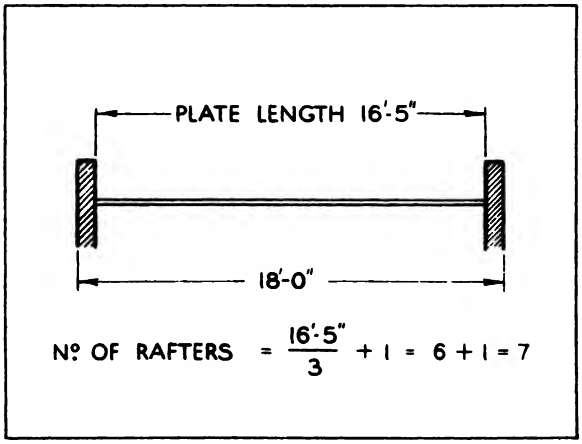


Fig.1 Method of Calculating number of Rafters.

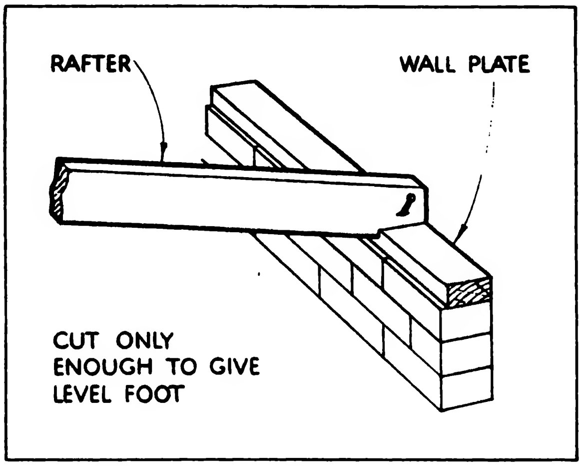


Fig.2 Cut on Lower End of Rafter.

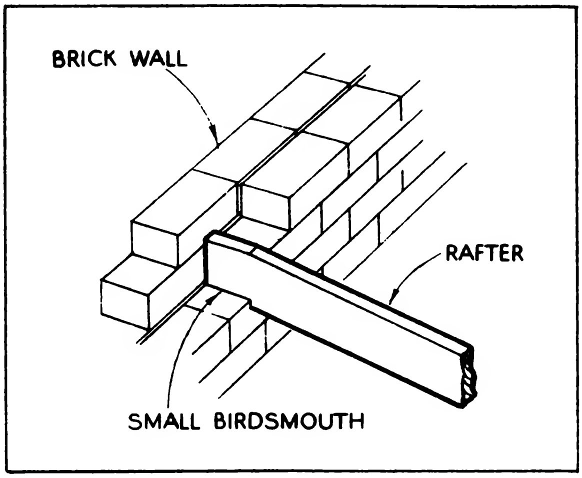


Fig.3 Cut on Upper End of Rafter.

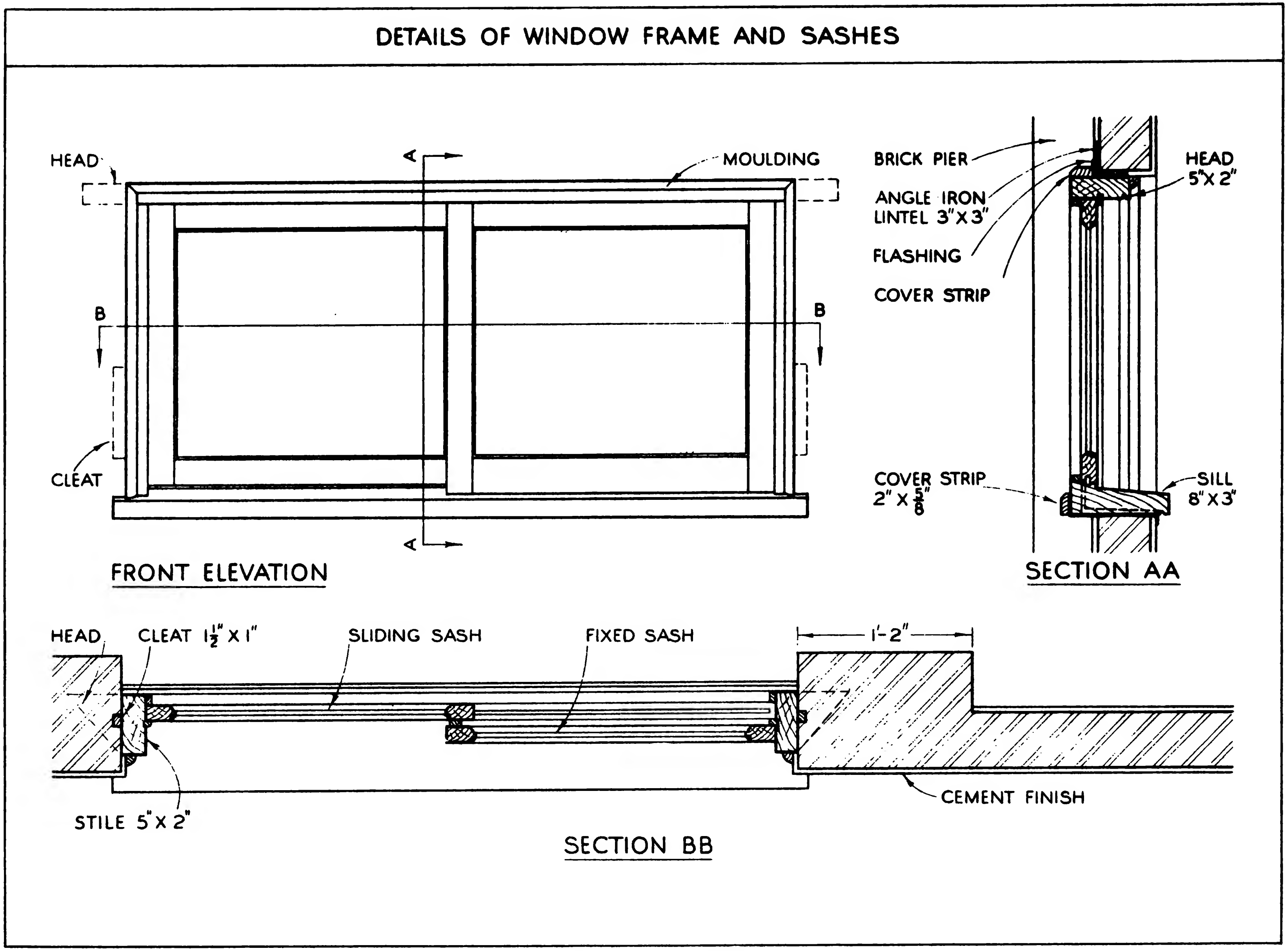


Fig.1 Front Elevation and Sections of Window Frame and Sashes.

FITTING THE OUTER SASH.

The sashes are supplied by the joiner and made very closely to the size of the frame. The sliding sash has a narrower bottom rail than the fixed one and is grooved along the bottom edge to fit over the track. The sashes must be fitted to the frame in the arrangement shown in the detail drawing in Fig. 1.

Fit the outer sash first. Its stile takes the place of a mullion in the frame and it should be used to assist in keeping the head and sill of the frame parallel to one another. This is most important in a frame with a sliding sash. After fitting the sash to the frame, check the inner sash with the size of the remaining opening to see that the closing stiles of the separate sashes are well made of uniform width. If the sizes are satisfactory, the outer sash is fixed to the frame with skew nails.

FITTING THE INNER SASH.

All the stop beads are removed while the inner sash is fitted. One stile should fit closely to the frame and the other stile covers accurately the meeting stile of the outer sash. There should be a sliding fit in the height between the head and sill of the frame, and a clear view through the height of all the glass in both sashes when they cover one another when the window is open.

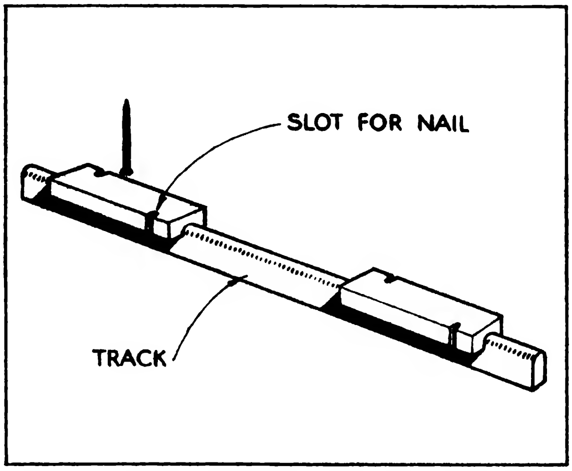


Fig.2 Detail of Patent Track and Bearings.

A detail of the patent track and bearings is shown in Fig. 2. The bearings should be spaced as far apart as possible along the bottom edge of the sash and be accurately housed. The depth of housings is measured by inserting the track in the sill groove and balancing the bearing on it as shown in Fig. 3. This measurement is shortened by fully $\frac{1}{16}$" to give running clearance between sash and sill.

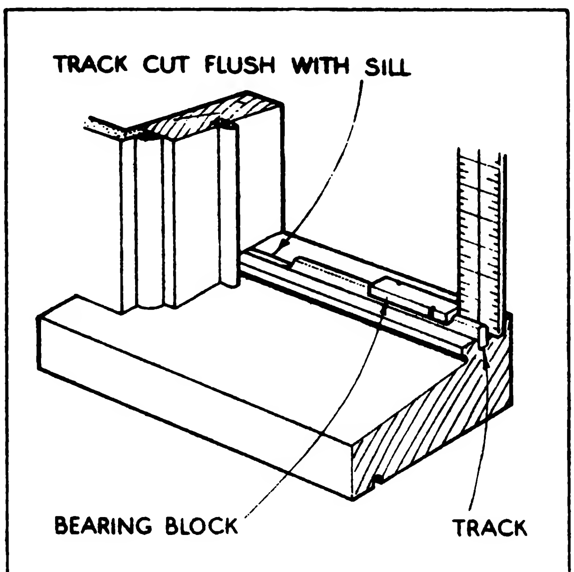


Fig.3 Method of Measuring Depth of Housings.

It will be noticed that approximately $1\frac{1}{4}$" length of track at the frame end has been cut down to the level of the sill. This is done to provide an outlet for any accumulated rain water which may be swept along the back of the track when the sash is being closed. The weep holes must also be cleaned out before the sash is installed.

FIXING THE BEARING BLOCKS.

The bearing blocks are fixed in the sash as shown in Fig.4, and given a trial run along the track.

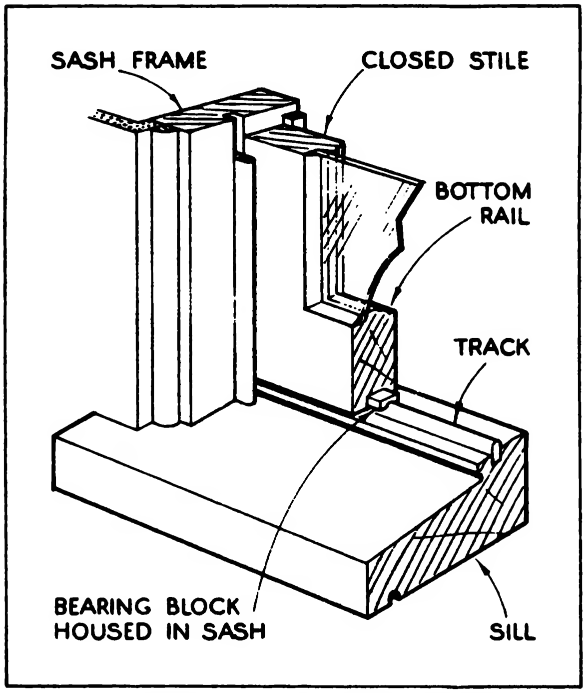


Fig.4 Method of Fixing Bearing Block.

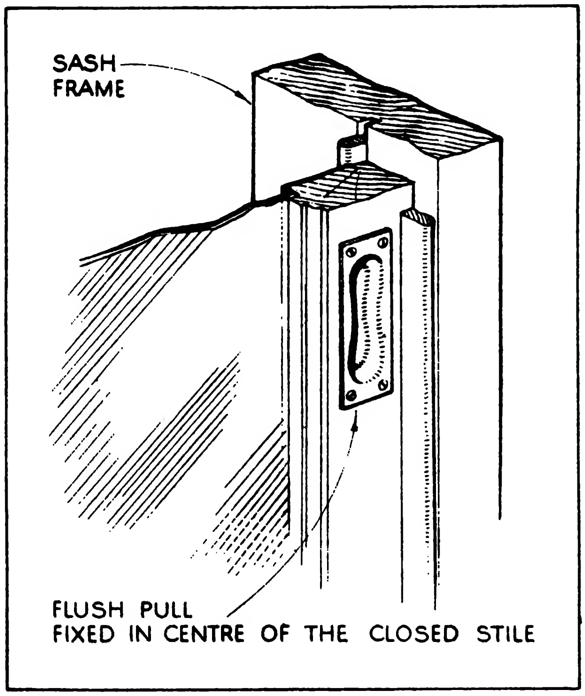


Fig.5 Position of Flush Pull on Stile.

When the fit is satisfactory, mark on the closing stile the thickness of the bead to obtain centring for the flush pull to be fixed as shown in Fig.5. Attach the two flush pulls required by the specification.

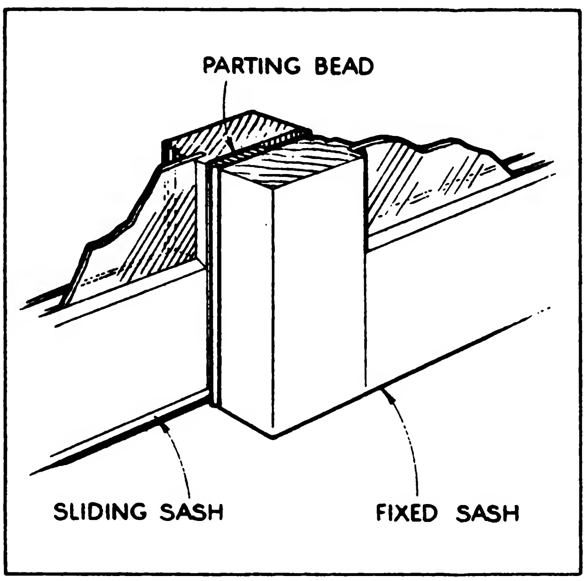


Fig.6 Positions of Meeting Stile Beads.

FIXING THE BEADS.

The meeting stile beads are fixed as shown in Fig.6, before nailing the staff beads to the frame. The staff beads form the running grooves for the top and bottom of the sliding sash and cover the junction of its stiles with the frame.

The addition of the Barrel Bolt completes the operations of fitting and locking the sashes.

FIXING THE COVER STRIPS.

The cover strips are fixed to the frame to protect the edges of the flashing, in positions as shown in detail drawing in Fig. 1.

FIXING THE DOOR TRACK.

The metal track for sliding doors makes good running possible only when fixed with great accuracy. The door frame must be plumb and both the track and the floor must be level.

Pegs must be driven securely in the ground along the line on which the doors will travel, especially at the points of the door frame stiles and at other points where the brackets of the track will be fixed. The pegs must be accurately levelled to floor height with the aid of a spirit level and a straight edge.

USING A HEIGHT ROD.

A height rod must be made and clearly marked with lines measured from the doors and hangers before putting it to the height between pegs and brackets, as shown in Fig. 1. These pegs will be used later on by the pavior for his levels when making the concrete floor.

Check the height of all the doors and make sure that the set of three will make one uniform height.

ERECTING THE DOOR FRAME.

The door frame is erected in loose pieces. Stiles are cut to the length of the rod, with their shoulders under the head and the tops cut to the height of the track, as shown in Fig. 2.

The stiles are fixed to plugs which are spaced at approximately 2' centres. Timber plugs are made wherever possible of fine straight grained softwood.

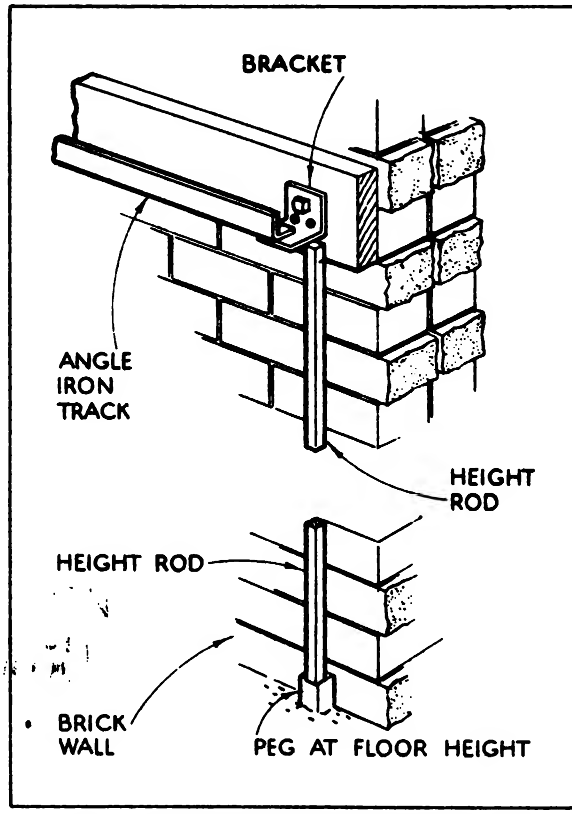


Fig.1 Measuring Height with Height Rod.

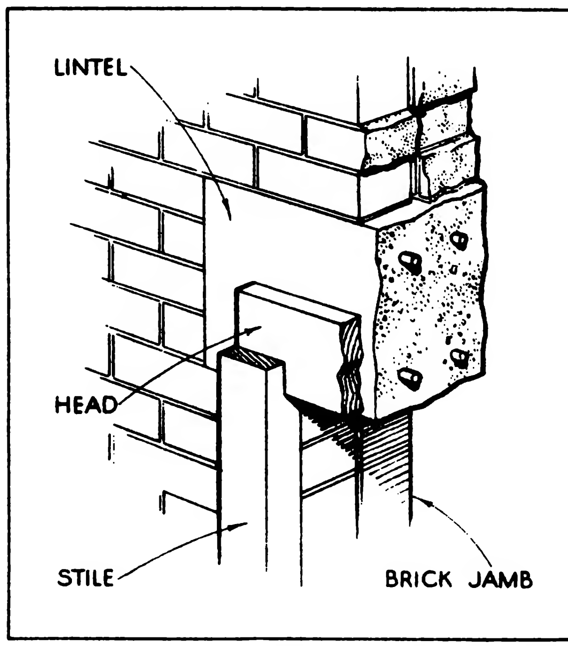


Fig.2 Method of Fitting Door Stile and Head.

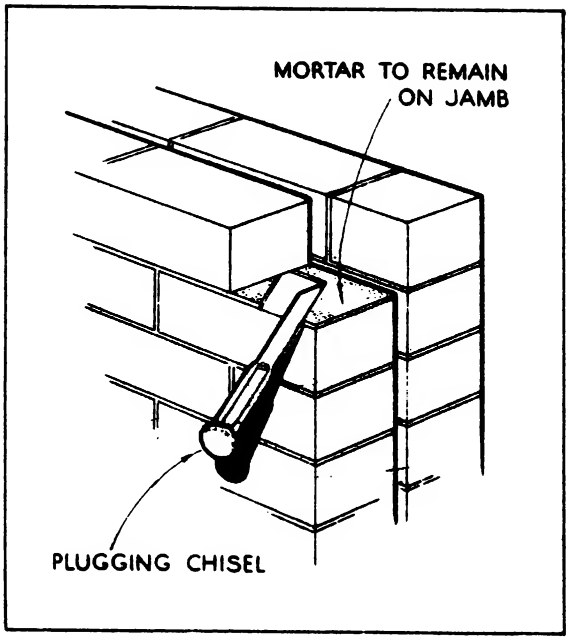


Fig.3 Mortising the Holes for Timber Plugs.

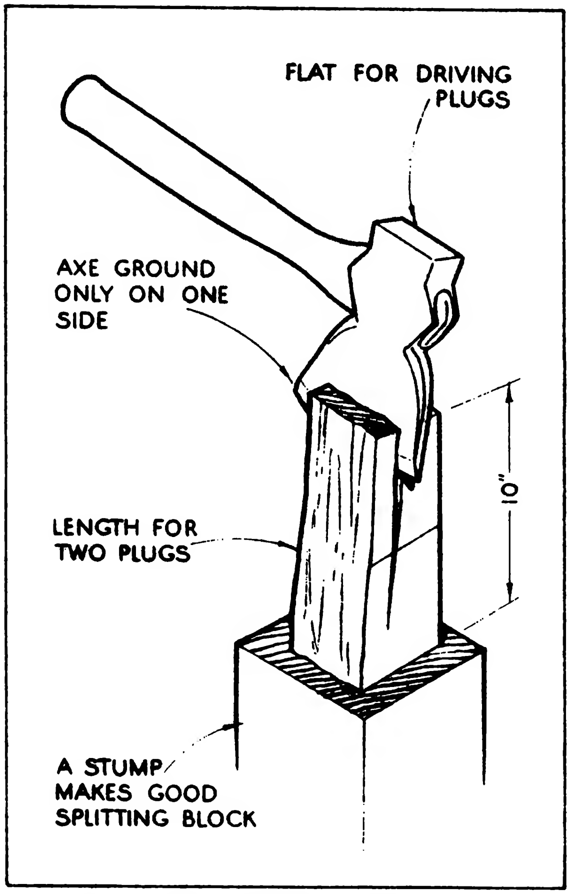


Fig.4 Method of Making Timber Plugs.

FIXING THE TIMBER PLUGS.

Select horizontal joints with good thickness between the bricks, mark on them the width of a stile, and mortise out the mortar with a plugging chisel or drill. Care must be taken when mortising the holes that mortar is not driven out of the joint on the face of the brick jamb. The risk of this occurring is diminished by cutting as far away from the corner as possible, and making the holes on the skew as shown in Fig.3.

The timber plugs should be split with a bench axe so that their lengths run parallel to the grain in the timber. Cross grained timber does not drive into holes and does not effectively hold nails or screws. Cut the timber into lengths of approx. 10", split the required width and thickness, trim the faces with an axe or chisel to make a slight taper towards both ends, and cross cut in the centre as shown in Fig.4, to give two plugs from the 10" length.

Drive a plug in each hole and cut off projecting ends with the cross cut saw. A broken end is rough and jagged and does not give a nail or screw a fair chance of entering the plug directly opposite to its centre. Thus the timber which is being fixed is frequently pulled out of line by the screw.

FIXING THE STILES.

The positions for the holes in the stiles are fixed by the positions of the plugs in the brickwork. The holes are countersunk before fixing in position with heavy wood screws.

The edges of the stiles are kept at $\frac{1}{8}$" inside the face line of the brick jambs, to avoid being caught and dislodged by any passing vehicle.

FIXING THE HEAD.

The head of the frame is secured to the concrete lintel either by anchor bolts set in the concrete or by screws and expansion plugs, as shown in Fig.5.

Space out and bore countersunk holes in the head, but do not make the holes too close to the bottom of the lintel, otherwise the expansion plugs will break off chips from the concrete.

Hold the board against the lintel and mark through it the centres for the plug holes, then remove the board and drill the holes in the lintel.

A special drilling tool is made for this type of work. It cuts holes quickly, straight, and to the correct size. The tool consists of a head piece which takes the hammer blows, and one end is machined to hold drills. Drills of varying sizes and a standard size shank are interchangeable in the head piece. The release of a drill is effected by driving a wedge through the slot shown in Fig.6. The drills are tapered shank and are free from the difficulty of jamming into the head.

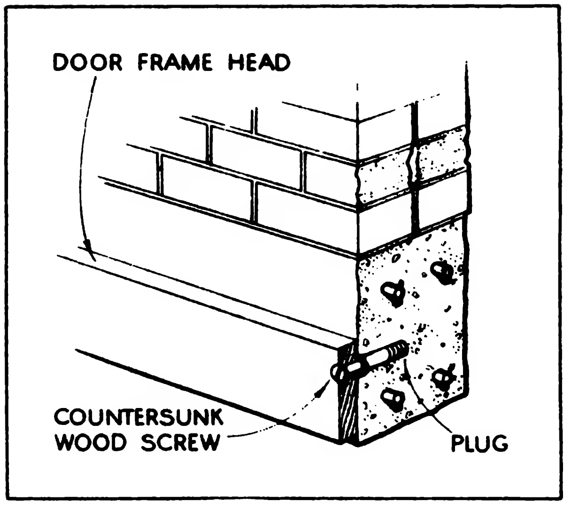


Fig.5 Head of Frame Fixed with Special Screw.

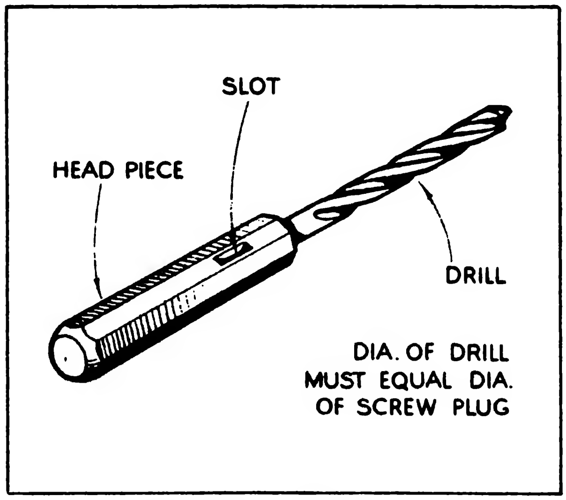


Fig.6 Special Drill for Making Plug Holes.

Metal plugs are patent in construction and are obtainable for either bolts or wood screws. They expand when a pulling force is exerted inside them and grip securely around a drilled hole. The plugs are laid in the drilled holes, the head of the frame is placed in position and acts as a washer against the metal plug while the screws are driven home through them.

FIXING THE METAL TRACK.

A fixing board is plugged to the side wall on the level of the head of the door frame and the corner between them is bridged by a piece of the same material fixed at an angle of 45 degrees and tangent to the circular bend in the track.

The brackets attached to the metal track are secured to the head and fixing board. Check them with the aid of the height rod standing on the pegs, as shown, and lubricate the track with grease to assist in easy action of the doors.

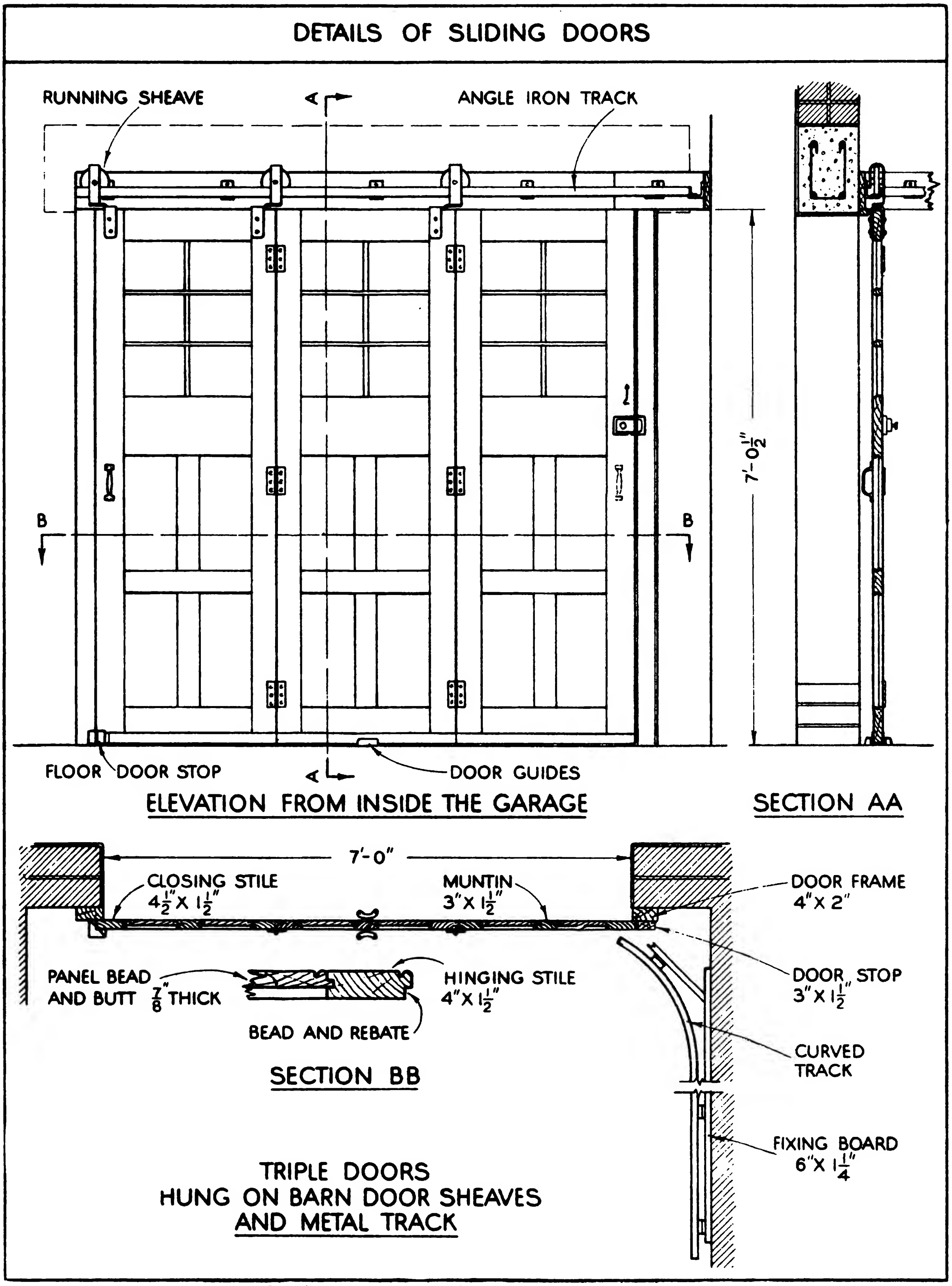


Fig.1 Elevation and Sections of Triple Sliding Doors.

THE SLIDING DOORS.

The sliding doors are supplied by the joiner in a set of three separate doors, as shown in the detail drawing in Fig.1. The edges of the doors are rebated and beaded where shown so that they fit together to make the required overall width.

The height of the doors must be uniform and the rails make straight lines. Short horns are left on the stiles to protect the edges of the rails during the transport of the doors. Good running of sliding doors is dependent on accuracy in fixing the overhead metal track and in levelling the floor, and in accurately setting the guides which control the bottoms of the doors.

Some arrangement will be necessary on which to lay the doors while hinging them together, such as two pieces of straight scantling carefully placed parallel to one another without a twist. A very suitable working height is made by placing these scantlings as ledgers on saw stools.

HANGING THE SLIDING DOORS.

The doors are laid on the ledgers and fixed together with surface hinges. This type is one of the easiest of hinges to fix but still they require careful adjustment. Use a long straight edge at each joint to make sure that the centre lines of the hinge knuckles form one straight line directly over the joint line of the doors, as shown in Fig.2. A close joint of approximately $\frac{1}{8}$" of an inch is all the opening required for doors that are hinged and slide. They move apart quickly when operated and any swelling through dampness is passed on along the set and is adjusted without trouble at one end.

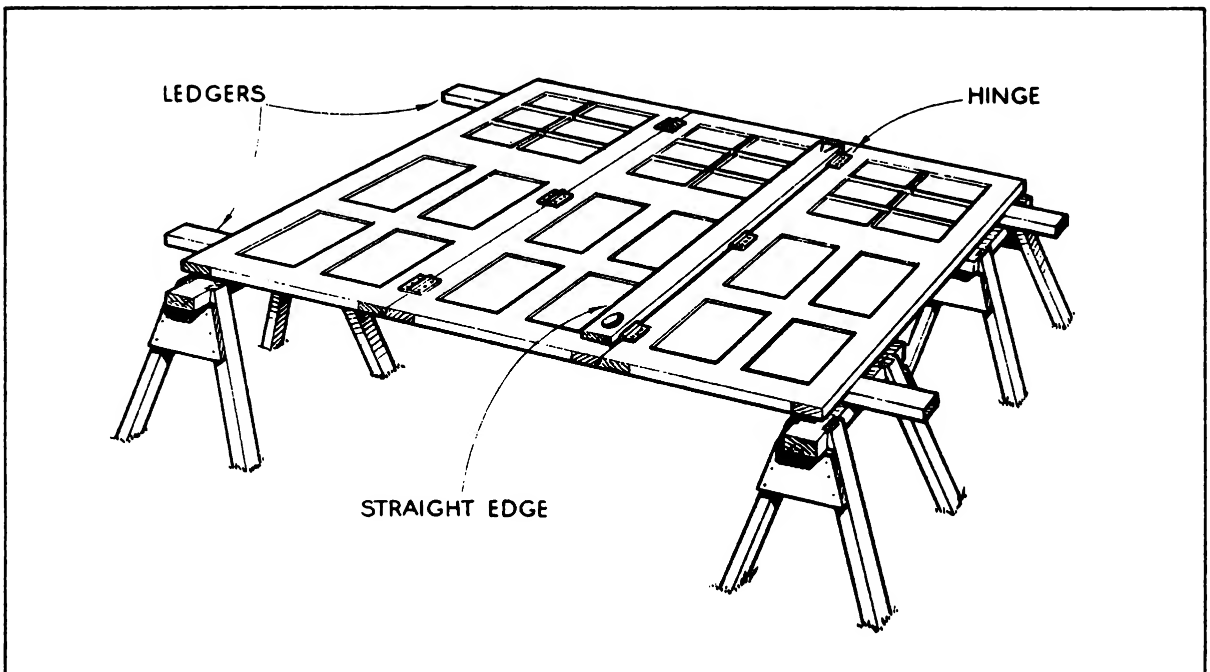


Fig.2 Doors Laid on Ledgers and Fixed Together with Surface Hinges.

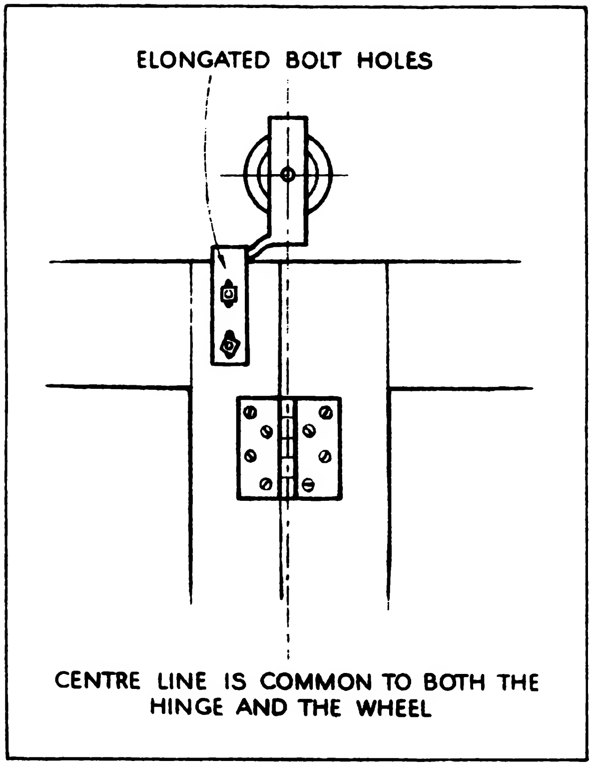


Fig.3 Method of Fixing Hanger to Door.

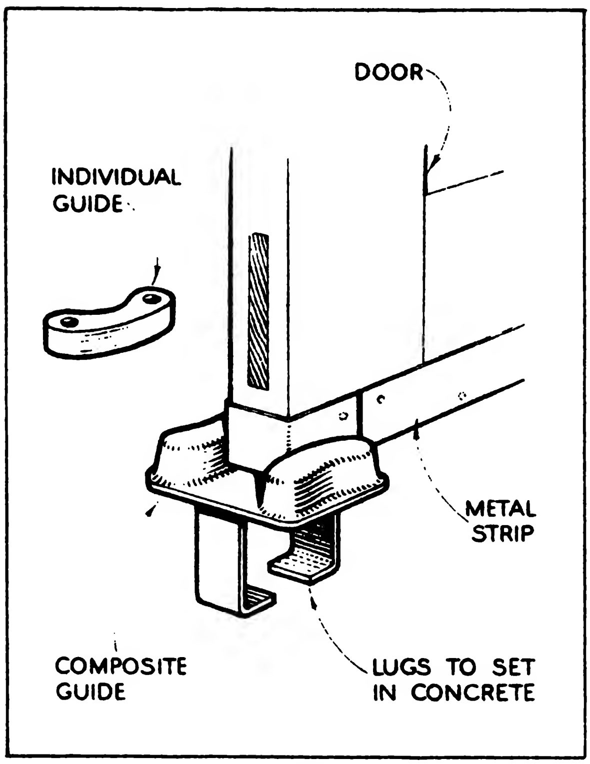


Fig.4 Floor Guide for Doors.

Check the overall sizes and the squareness of the doors with the opening in the brickwork, and then trim up the doors to their correct dimensions.

The hangers which saddle the tops of the doors are manufactured in a variety of sizes to suit doors of various thicknesses, or are made so that they can be adapted over a range of sizes. Each hanger requires fitting to its door with the centre line of the running wheel above the centre line of the hinge knuckles, as shown in Fig.3.

A slight adjustment of height is usually provided by some screwing device in the hanger, or by elongated bolt holes as shown in Fig. 3.

This reduces the number of times that the doors must be lifted from the flat to the upright positions while they are being fitted.

Lubricating grease is applied to the hangers before the doors make their first run. The doors are then lifted upright and their hangers threaded on to the track.

<u>FIXING THE FLOOR GUIDES.</u>

Metal floor guides of kidney shape may be obtained in one piece, which is made up of a pair of guides on a bottom lug ready to be set in the concrete. The door slides between the guides as shown in Fig.4. To give the leading door its right direction a number of these guides may be used along the line of movement.

Metal floor guides are also made in separate guides with countersunk holes through them. This type has the advantage of being able to be spaced and fixed to suit the design of the doors.

THE DOOR FITTINGS.

A Rim Night Latch, as shown in Fig.5, is operated from outside the doors by turning the key in a cylinder, or from the inside by turning a knob. Several makes of latches are obtainable. The cylinder is usually $1\frac{1}{4}$" diameter, and requires a centre bit hole bored squarely through the door with the centre $2\frac{3}{8}$" from the edge of the door.

The key cylinder is held on the door by screws through a back plate as shown in Fig.6. Long screws are provided and are scored at lines in their length so that they can be readily snapped off to fit thinner doors. The flat projecting bar is the connecting link that turns with the key to operate the locking bolt.

Part of the bolt case in some locks requires recessing into the edge of the doors before connecting up the case with the cylinder. The staple that holds the bolt when the door is closed is partly recessed into the door frame and is fixed by wood screws.

A Hook and Eye, as shown in Fig.7, is required for holding the locking door against its neighbours in the set while the sliding movement is carried out. Bore holes in the doors for all the screw eyes.

Pull Handles of the D type are fixed on the inside of the doors. They may also be attached to the outside if the curve of the track gives clearance between them and the door frame. Take care that their height line is above or below the lock staple as there may be insufficient room for one to slide past the other.

Stops are fixed to the door frame and the wall after the doors have been given several movements along the whole of their track. Cover strips are fixed where required.

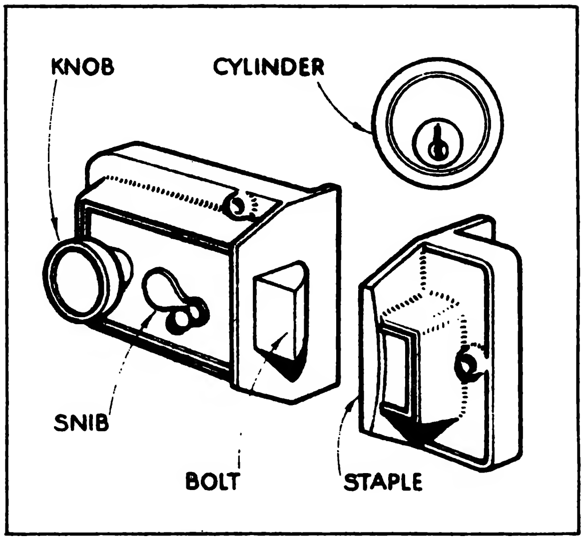


Fig.5 Rim Night Latch.

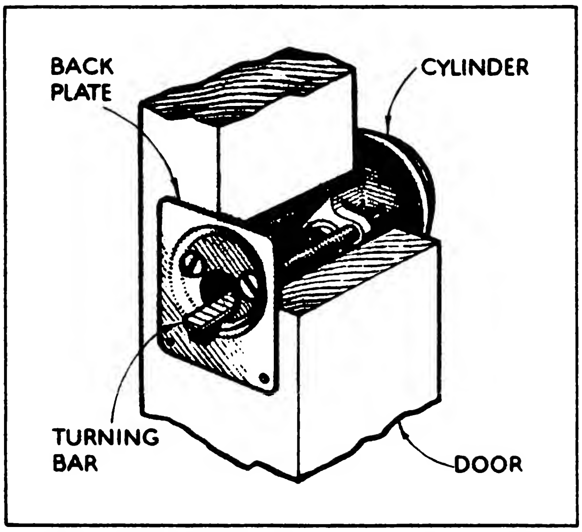


Fig.6 Section Showing Lock Cylinder Fitted.

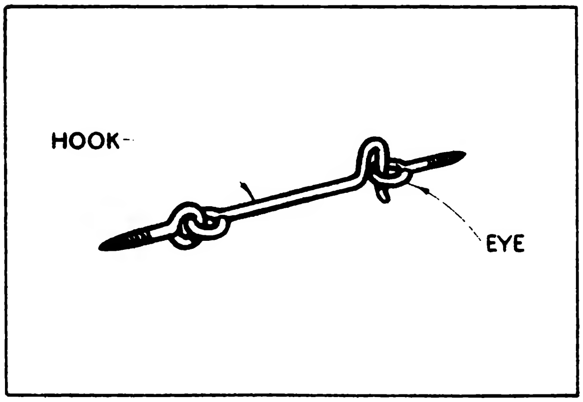
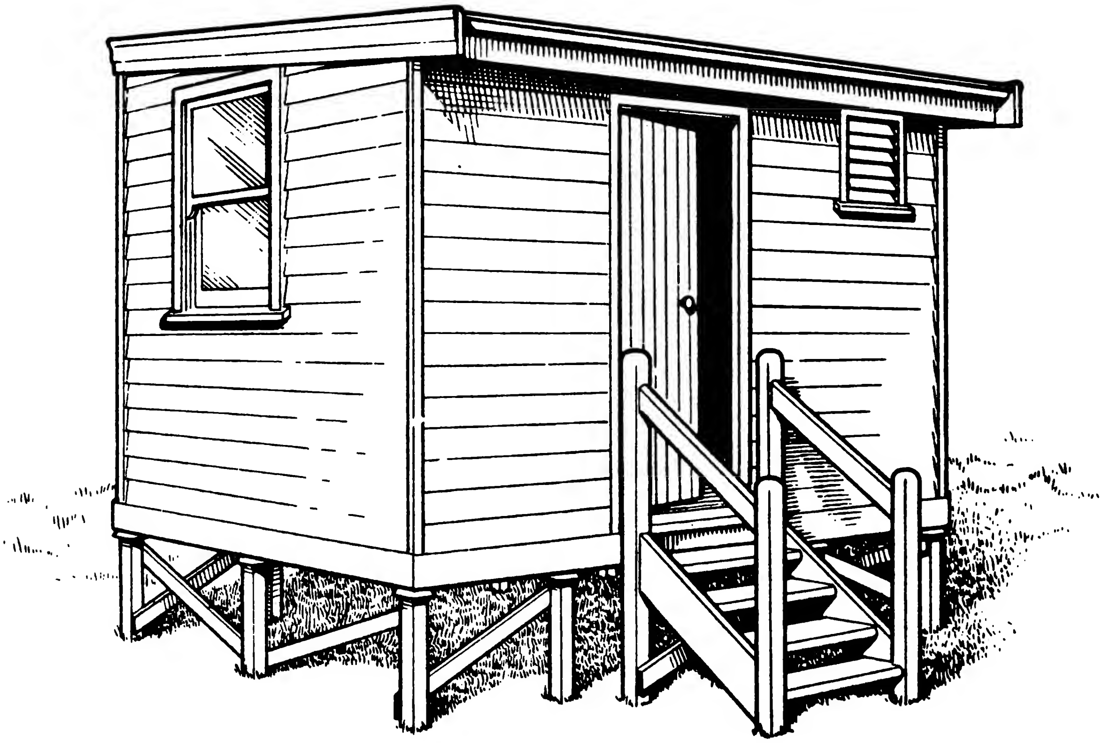
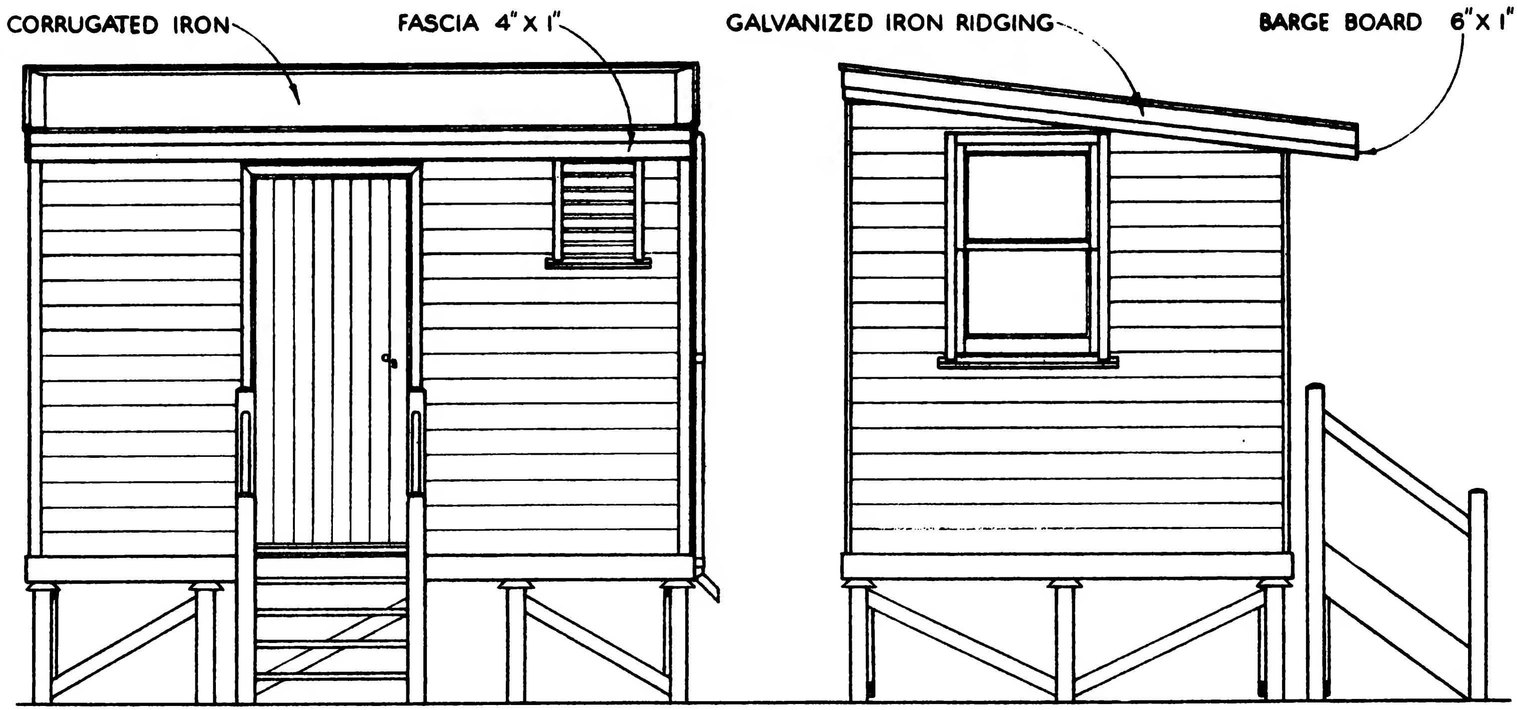


Fig.7 Hook and Eye for Holding the Locking Door.



PICTORIAL VIEW OF OUTHOUSE.

TIMBER FRAMED OUTHOUSE



FRONT ELEVATION

END ELEVATION

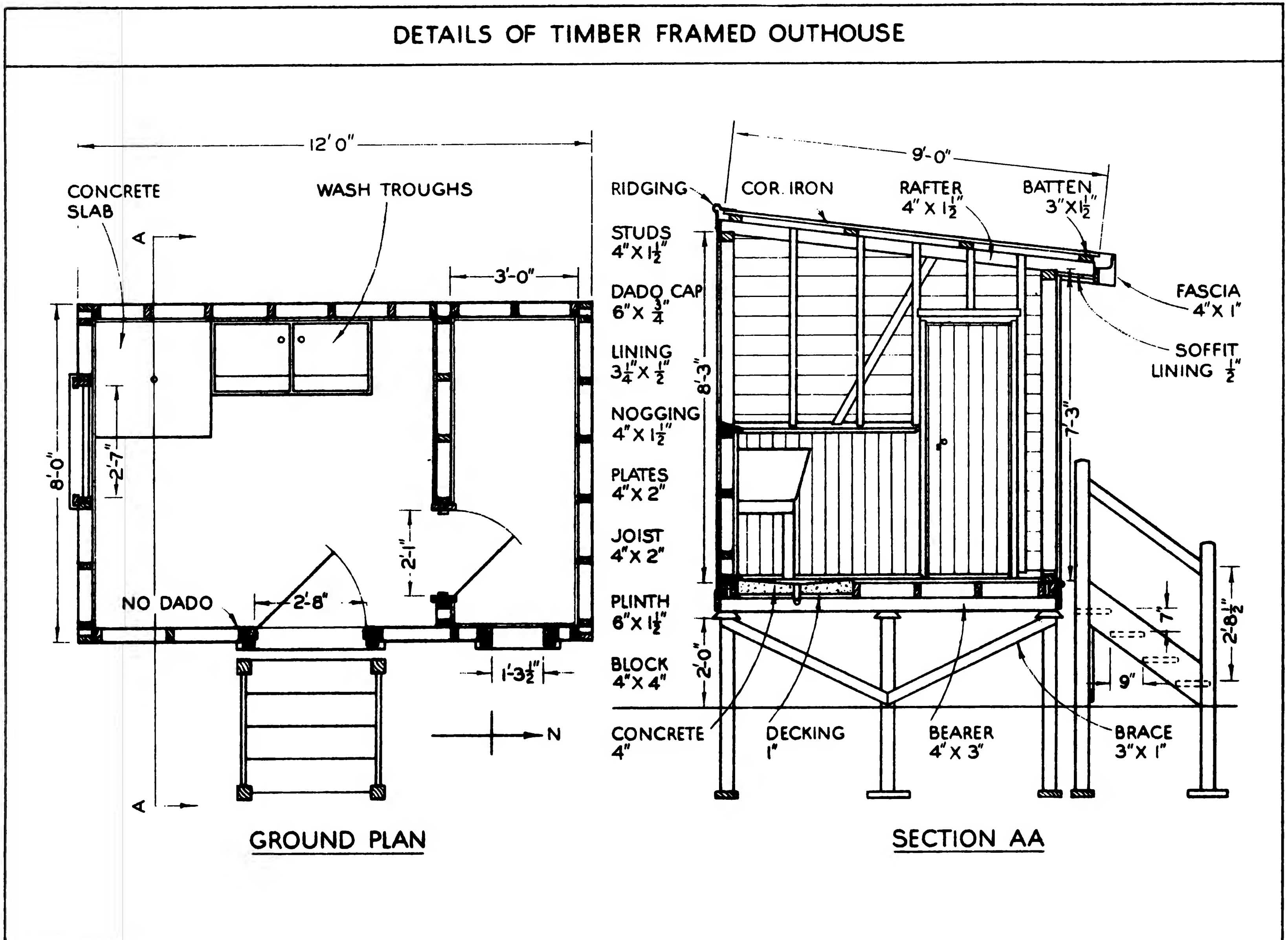


Fig.2 Ground Plan and Section of Outhouse.

GENERAL SPECIFICATION.

A timber framed outhouse is to be erected to the following specifications and to the dimensions shown in the accompanying Plans and Detail Drawings.

The outhouse is detached and has its eastern side parallel to an existing main building with a space of 10 feet between their respective foundations. The outhouse has a skillion roof covered with corrugated iron and the walls are covered with round edged weatherboards. The floor bearers are built not less than 2 feet above the ground level with a clear space around them to allow detection of attacks by pests.

SPECIFICATION OF MATERIALS.

SUBSTRUCTURE & FLOOR CONSTRUCTION:

Blocks	4" x 4"	Red Gum or Jarrah, spaced at not more than 4' centres.
Braces	3" x 1"	Red Gum or Jarrah.
Sole Plates	6" x 1½"	Red Gum 12" long.
Ant Caps	26 gauge galvanized iron, projecting 2" level measurement and at 45 degrees.	
Bearers	4" x 3"	Hardwood, spaced not more than 5' apart.
Floor Joists	4" x 2"	Hardwood, spaced not more than 1'6" apart. Double joists under walls that are running in the same direction as the joists.

WALLS:

Top & Bottom Plates	4" x 2"	Hardwood.
Common Studs	4" x 1½"	Hardwood, at 1'6" centres.
Door Studs	4" x 2"	Hardwood.
Corner Studs	4" x 2"	Hardwood.
Braces	2" x 1"	Hardwood.
Nogging	4" x 1½"	Hardwood.

ROOF:

Rafters	4" x 1½"	Hardwood, at 3' centres.
Battens	3" x 1½"	Hardwood, at 3' centres.
Fascia	4" x 1"	Hardwood.
Soffit Lining	3½" x ½"	T. & G. Lining.
Barge Board	6" x 1"	Hardwood, dressed.

WALL COVERING:

Plinth	6" x 1¼"	Dressed.
Weatherboards	7"	Round Edged.
Stops	2¼" x 1¼"	Dressed.

(NOTE: Other suitable types of timber may be specified.)

ROOF COVERING:

Galvanized Corrugated Iron, 26 gauge, 2 corr. side lap.		
Spouting	5" x 3"	Galvanized Iron.
Down Pipe	2"	Galvanized Iron.
Capping	12"	Galvanized Iron Ridging.
Flashing	26 gauge	galvanized iron.

INTERIOR WALLS:

Laundry Dado Lining	$3\frac{1}{2}$" x $\frac{1}{2}$"	T. & G. fixed vertically, with capping and quarter round as shown.
Lavatory Lining	6" x $\frac{1}{2}$"	T. & G. fixed horizontally on all walls from floor line to roof.

JOINERY:

Doors constructed to detail drawing, hung on tee hinges, and fitted with 6" Rim Locks.

Window constructed to detail drawing, hung with spiral sash balances, and fitted with sash lifts and fastener.

Louvre Frame constructed to detail drawing. The louvres are wire cast glass.

Entrance Steps constructed of dressed material, shaped as shown in plans and of the following nominal sizes :-

Newels	4" x 4"	Red Gum or Jarrah.
Sole Plates	6" x $1\frac{1}{2}$"	Red Gum or Jarrah.
Brace	3" x 1"	Red Gum or Jarrah.
Strings	10" x $1\frac{1}{2}$"	Red Gum or Jarrah.
Treads	10" x $1\frac{1}{2}$"	Red Gum or Jarrah.
Hand Rail	3" x 2"	Red Gum or Jarrah.

ORDER OF PROCEDURE.

1. Substructure is erected.
2. Long walls are constructed.
3. End walls and roof are constructed.
4. Window, door and louvre frames are built into the walls. (The louvre frame is made on the job).
5. Outside of walls is covered.
6. Roof is covered.
7. Flooring is nailed down.
8. Partition wall is framed up.
9. Doors are made.
10. Sashes and outside door are fitted and hung.
11. Interior linings and fittings are completed.
12. Steps are built.

Note: The steps are a separate unit and can be built at any time after the walls are covered. They have been made the concluding item in the list so that the description of their construction will not break into the order of erecting the building.

SUBSTRUCTURE FOR TIMBER FLOOR.

The substructure required for a timber floor is built up on blocks with a series of cross timbers. Those fixed on the blocks are known as bearers. They are strong and fairly widely spaced. Across the bearers are fixed the lighter members, called floor joists, and in turn across the joists come the thinner flooring boards.

The outside walls stand on the floor joists and usually enclose the whole of the building before the flooring is laid. In some cases, the partitions which divide the whole floor area into rooms are also built directly on the floor joists, but in other cases, where partitions are of light weight construction, the floor is put down and the partitions constructed on them. The latter method is utilized in the job in hand.

It is usually specified that a bearer must be placed directly under a wall running in the same direction as the bearers. The direction of the bearers going across the building does not perhaps appear to give the cheapest construction but it has been chosen for several reasons. One is that it sets the direction of the joints between the floor boards to run directly towards the entrance door; another reason is to have bearers at two sides of the concrete slab that forms the base of the laundry copper. In a job of such light construction as the one being built, it is not really necessary to do so, but advantage has been taken of the maximum spacing allowed to place one under the partition.

THE BUILDING LINES.

Lay out the building lines with stakes and pegs. The No. 1 Line is made parallel to the existing building at the required distance from it. Take the other sides of the rectangle parallel or square from No. 1 Line to the required dimensions, and check the squareness of the rectangle by testing the diagonals.

THE SUBSTRUCTURE BLOCKS.

The holes must be dug deeply, the best block for a position selected, and then rammed into the hole and made plumb in its correct position. Blocks that are at such a convenient height above the ground level can be cut to correct height after being rammed in place and braced up. This method of levelling and cutting the blocks after they are in the ground has the great advantage of allowing correction of any upward creep that has occurred during ramming of the earth around them. A few blows on the top with a spare block will be effective, and levelling is then commenced.

As each row of blocks is cut to line, the metal caps are placed on the tops and the bearer skew nailed through them to the blocks. Every nail driven through a metal cap must remain in place. If it is withdrawn the hole leaves a passage for termites to make an unseen entry to the building which they can readily destroy.

When bearers are only required in short lengths without spliced joints they are first cut to length and the spacing of the floor joists marked out on them. Each bearer is then nailed on its blocks.

The bearer requires to be held firmly in place while it is being skew nailed, as shown in Fig. 1, either by kneeling on it or by sitting astride it. Nails driven through both sides of the bearer make good dovetailed fixing between the two members. Any slight variation in the width of the bearers is levelled up in the operation of fixing the floor joists.

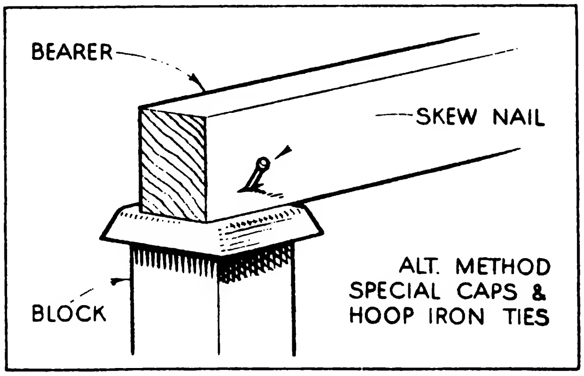


Fig. 1 Bearer Skew Nailed to Block.

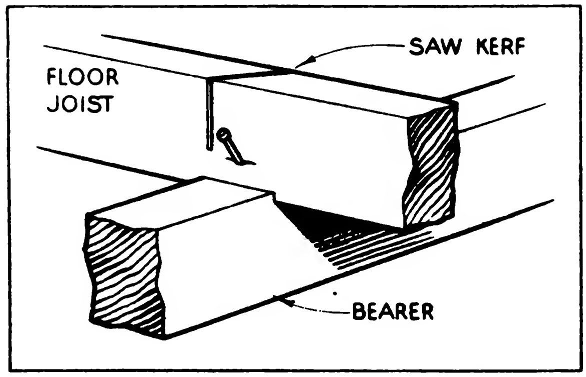


Fig. 2 Method of Taking Bow out of Floor Joist.

FIXING THE FLOOR JOISTS.

The floor joists are given outstandingface marks, and laid in approximate positions on the bearers. Selection is made for the narrowest ones to go at the ends of the bearers as the finishing height is determined by these. The top edges of the outside joists are made to come as straight and level as possible by sawing and chiselling from their bottom edges enough to allow them to sit firmly on the bearers. Then skew nail them down.

When a joist has its edge length curved and it resists nailing down sufficiently to warrant it, a saw cut is made partly through it, directly over a bearer, as shown in Fig. 2. The cut is made diagonally so that during straightening the two sides of the cut may come together at the top and glide along a greater distance than is necessary to close a square cut. Nail the outside joists to the bearers and lay the remaining ones flat on the bearere in their approximate positions. Then stretch chalk lines across the top edges of the joists directly over the bearers, as shown in Fig. 3.

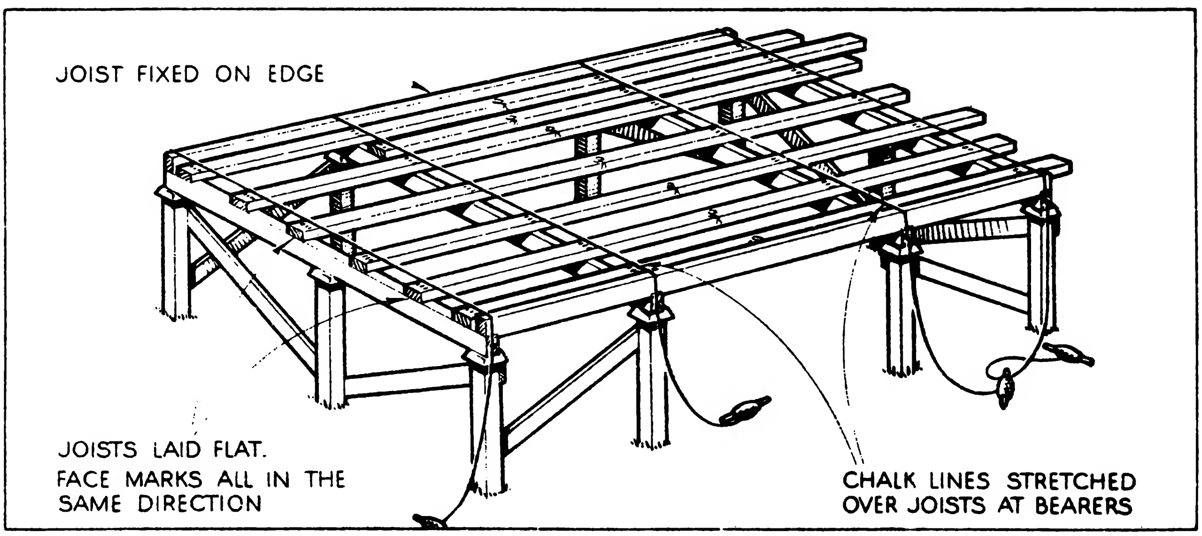


Fig. 3 Method of Setting Out Floor Joists to Obtain a Level Floor.

Keeping the saw and the chisel within easy reach, progressive movements are made along the bearers to gauge down the joists. Stand the rule directly in the position which a joist is to occupy, and measure carefully the height between the chalk line and the bearer, as shown in Fig.4.

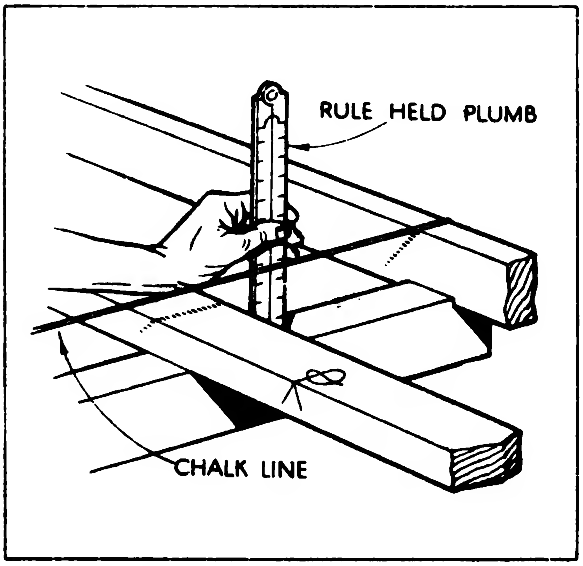


Fig.4 Measuring the Height of a Joist.

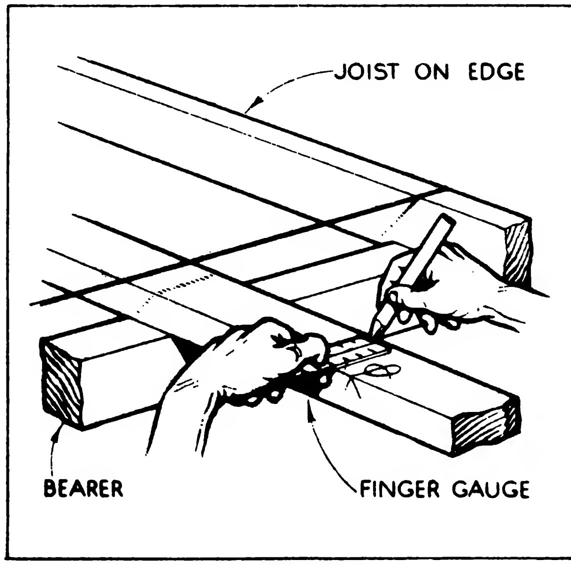


Fig.5 Marking the Height on a Joist.

Make a finger gauge on the rule, and after marking the measured height as shown in Fig.5, cut out the balance from the width of the joist. Test the joist under the line before laying it flat. On completion of the movements, nail the joists in their spaced out lines.

DECKING UNDER CONCRETE BASE FOR COPPER.

The concrete base at the corner where the copper is planned to stand requires decking between the joists. This decking is usually made up from either tongue and groove, or plain butt jointed, secondhand material, held together with ledges nailed to the underside. Provision is made in it for the brass floor waste, which is put in a central position, for draining the slab of concrete when the copper overflows.

CONSTRUCTING THE FRAME.

Fig. 1 illustrates a method of constructing the frame of the building with the 4" face of the bearer flat on the blocks, thus making it serve as a wall plate to join directly with the studs, as well as to provide a base for the floor joists

Where this construction is used, the "bearer wall plate" must be continued around under all the stud walls, and halving joints are used at junctions and corners to tie the plates together.

This method, however, has the disadvantage that the flooring is not always made to join with the outside covering, and spaces are left around the studs where vermin easily climb into the walls.

A further disadvantage is that the walls are not so readily brought to a uniform height if there is any variation in the 3" thickness of the plates between one piece of timber and another.

The introduction of the vermin plate as the bottom member in the wall framing, and standing the whole wall on top of the floor joists, as shown in Fig. 2, closes all the bottom wall spaces and makes it possible to construct each wall as an individual frame which can be completely nailed together.

The wall is framed up with its members laying on ground sleepers or on the floor joists. The frame is then easily transportable and is braced in position after the substructure of the bearers and joists has been completed.

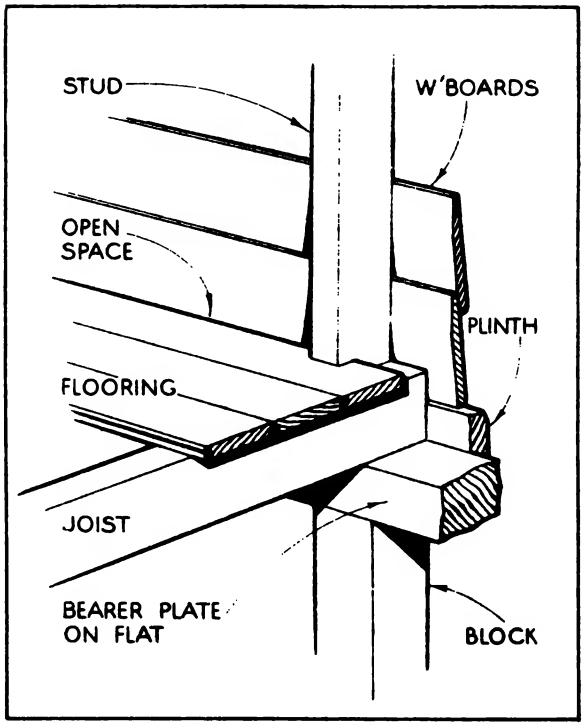


Fig.1 Construction of Wall Frame.

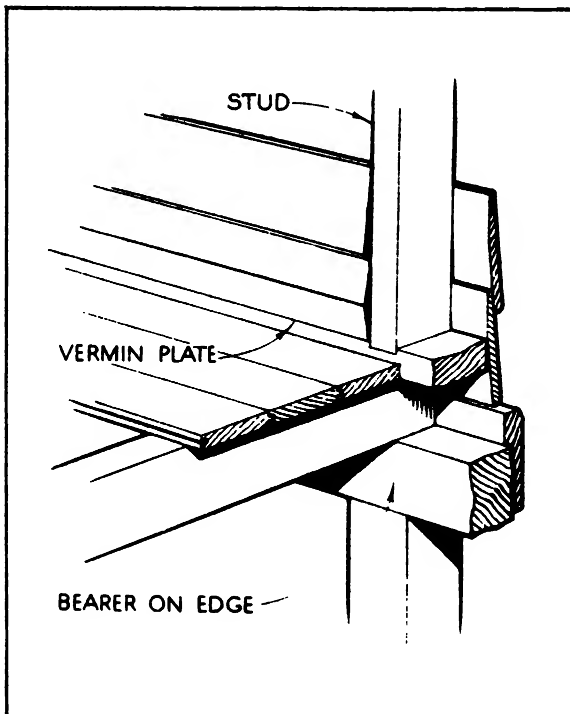


Fig.2 Use of Vermin Plate in Wall Framing.

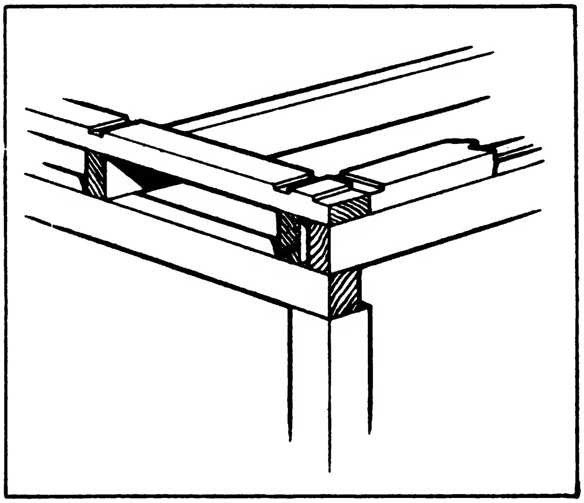


Fig.3 Vermin Plate at Wall Junctions.

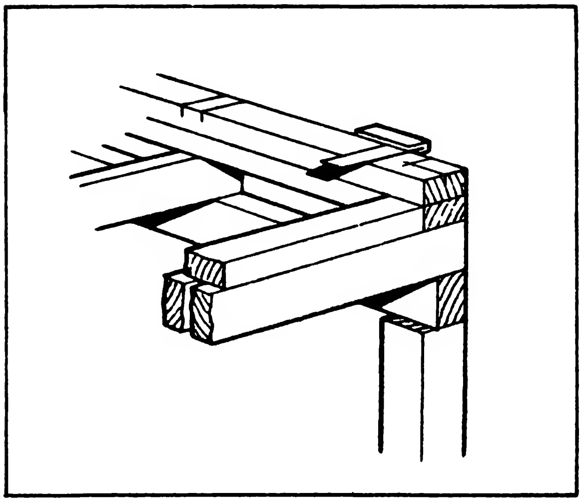


Fig.4 Setting Out Ends of Top and Bottom Plates

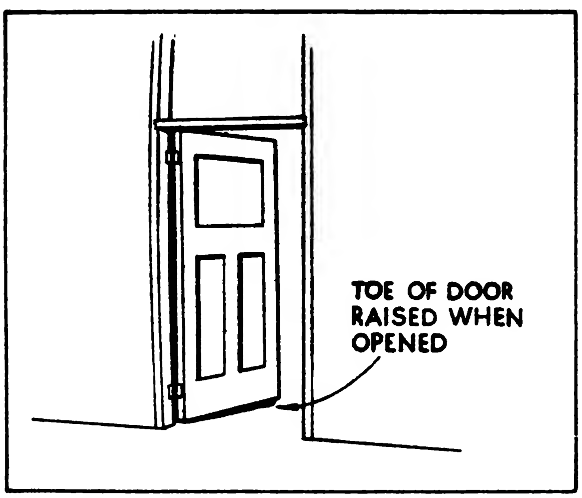


Fig.5 Effect on Door of Bowed Stud.

At the junction of walls, the vermin plates are not always joined with halvings; the one running across the joists is allowed to go full length while the other is cut to meet it with a butt joint, as shown in Fig.3. In the skillion or lean to roof, a rafter takes the place of a top plate in the cross wall. No overhanging plate is required and the ends of the top and bottom plates are set out as shown in Fig.4.

With the floor joists forming a bench, lay out the plates in their correct positions, set out the studs to the dimensions shown in the plans, cut the housings, and set out the rafters on the top plates. The studs of one wall will be shorter than the other, and are cut to their designed lengths.

The doors of the building being constructed will open towards the inside and it is therefore necessary to select the hollow edge on the length of the studs for the inside of the wall. This reversal of the directions followed in the previous projects is to retain the advantage of lifting the toe of the door higher off the floor when passing the 90° angle as it opens from its frame, as shown in Fig.5. If the wall line of the door hinges leans inwards at the top then the toe of the door will scrape the floor when it swings open. A big opening is then required between the door and the sill when the door is closed.

The construction of the walls follows the regular procedure, door and window openings being given the usual trimming. Both walls are assembled on top of the floor joists and erected plumb in their places. The floor joists give good nailing for the temporary braces that hold the long walls plumb until the cross walls make them rigid.

CUTTING THE RAFTERS.

After the side walls are erected the piece selected for a pattern rafter is placed on edge to bridge the span between the two walls, and the lines for its seating cuts are marked on it with a rule, as shown in Fig. 1. From the pattern the required number of rafters are cut to shape.

ERECTING THE END WALLS.

The end walls are now framed up with bottom plate, studs, trimmers, rafter and brace. The braces are so close in thickness to the rafters that they require nailing from under the sloping cut, the joint between these two pieces being given the shape shown in Fig. 2.

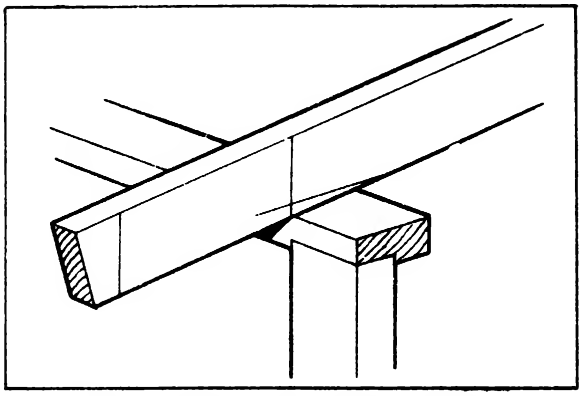


Fig.1 Marking the Pattern Rafter.

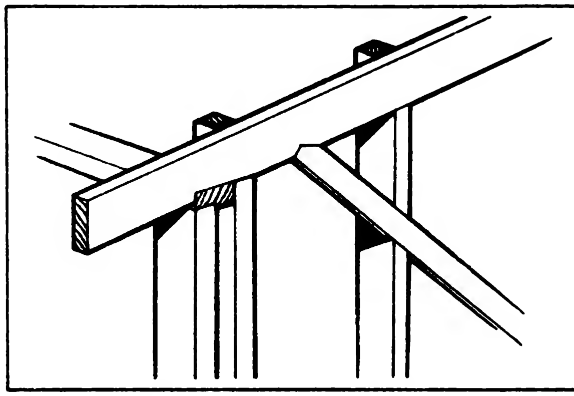


Fig.2 Method of Fixing Wall Brace.

PREPARING ROOF FOR COVERING.

Cut the rafter feet to line, fix the battens, fix the fascia with a fall in the direction required by the spouting, and nail the lining to the underside of the rafters. Extra fixing will be required for the lining between the rafters, and this is made with short ends of material between the fascia and the plate, as shown in Fig. 3. The usual fixing specified for a lining is at 18" centres. Long lining boards require their weight to be temporarily supported while the work of nailing them is being carried out. For this purpose cleats are packed down from the rafters and nailed up with enough slackness to allow them to pivot easily around the nail and to swing aside when not in use. Lining boards and cleats are shown in Fig. 4.

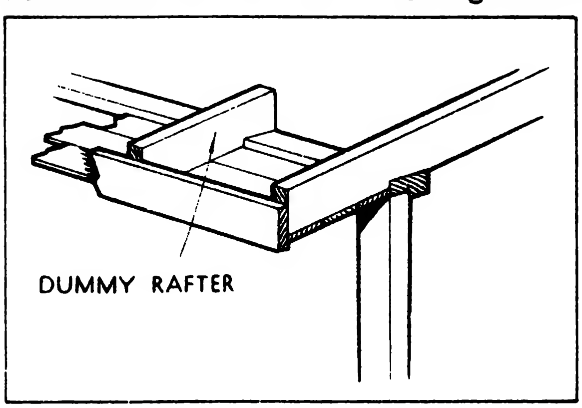


Fig.3 Fascia on Overhanging Eaves.

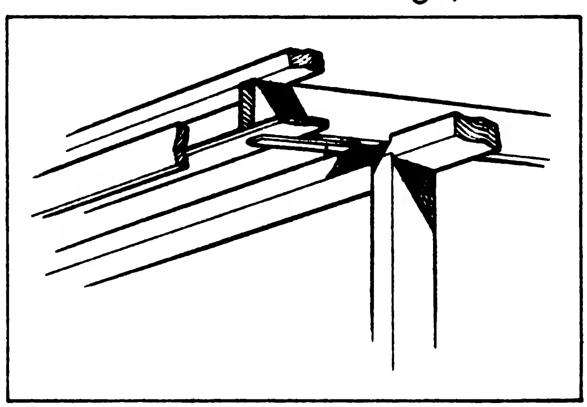


Fig.4 Cleat Support for Lining Boards.

DETAILS OF LOUVRE FRAME

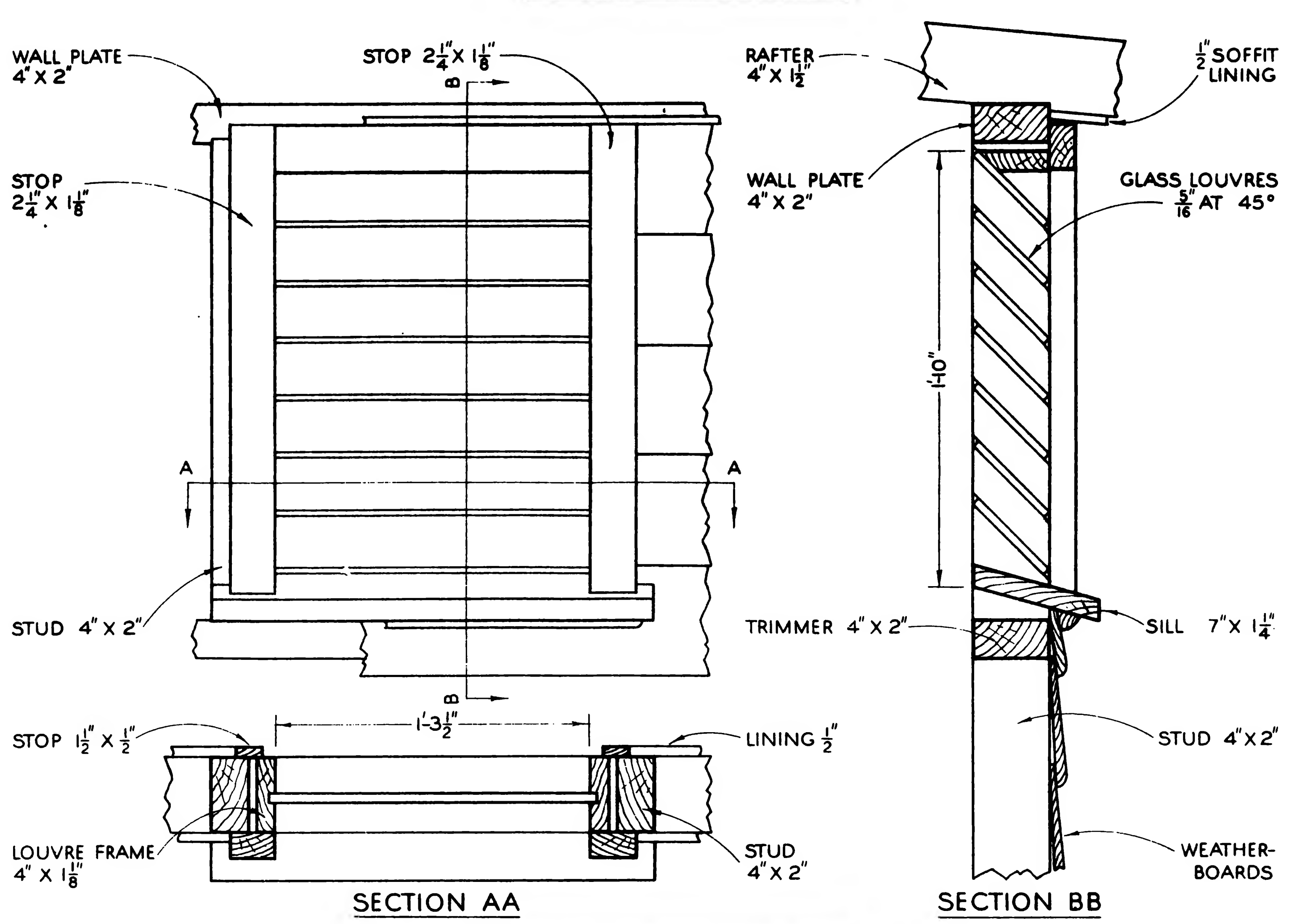


Fig.1 Elevation and Sections of Louvre Frame.

CONSTRUCTING THE LOUVRE FRAME.

Louvre frames are built to provide greater uninterrupted ventilation than would be obtained from standard wall ventilators. The frames are not of a regular size but are specially made to suit the situation.

Louvre slats are often made of semi-obscured glass and serve the double purpose of ventilating and lighting. The glass most commonly used is reinforced wire cast glass, which is roughly $\frac{1}{4}$" thick and has unpolished faces.

The louvre frame is of simple construction and is usually made on the job. A list of the materials required can be made from the detail drawing shown in Fig. 1. The full size material is utilised for a direct set out of the frame.

The stiles are prepared with trenches, as shown in Fig. 2. Tongues are cut on the ends of the head. These and the sill are housed into the stiles.

The sill must be given enough extra length past the stiles to the size of a stop and a "return". The "return" is cut to fit on the outside of the weatherboard which butts against the stop, as shown in Fig. 3.

The common spacing for louvres has one slat covering approximately one third the width of the one below it. The inside edge of the head is bevelled at the pitch of the louvres to give even spacing and to allow the louvre to be inserted in its trench after the frame is fixed in the wall.

Fix the $2\frac{1}{4}$" x $1\frac{1}{4}$" stops on the frame to match those on the door jambs, wedge the frame into the wall opening, check to see that it has no twist, and nail it to the studs.

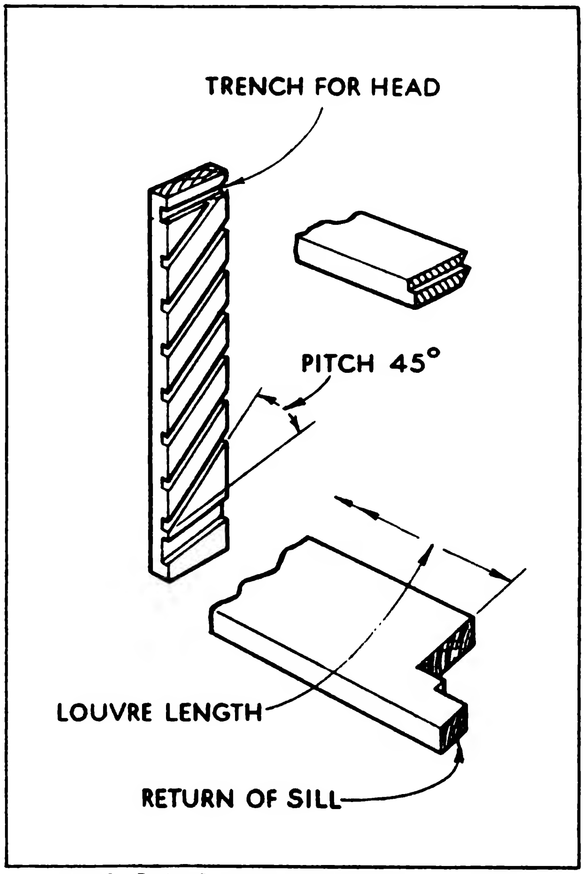


Fig.2 Details of Construction of Frame.

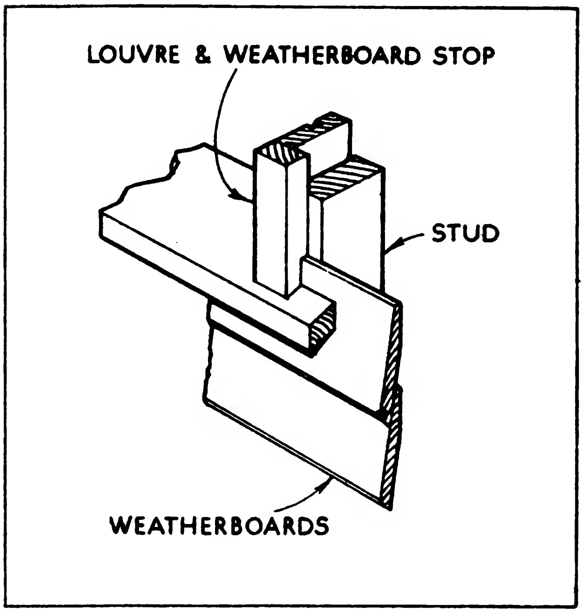


Fig.3 Method of Fitting Louvre Sill.

ERECTING THE WINDOW FRAME.

The sashes and frame are delivered from the joiner's shop. The sashes are prepared with grooves to suit the spiral balance. The frame is built into the wall so that the outside linings form a stop for the weatherboards. Care must be taken to wedge up the length of the sill in a level line and plumb up the stiles without any twist between their edges.

The flashing under the sill is often shortened so that by turning one end upwards into a saw kerf across the sill, as shown in Fig. 1, and turning the other end up the back of the stile, any rain water seeping through the sill joint will be drained to the outside of the wall.

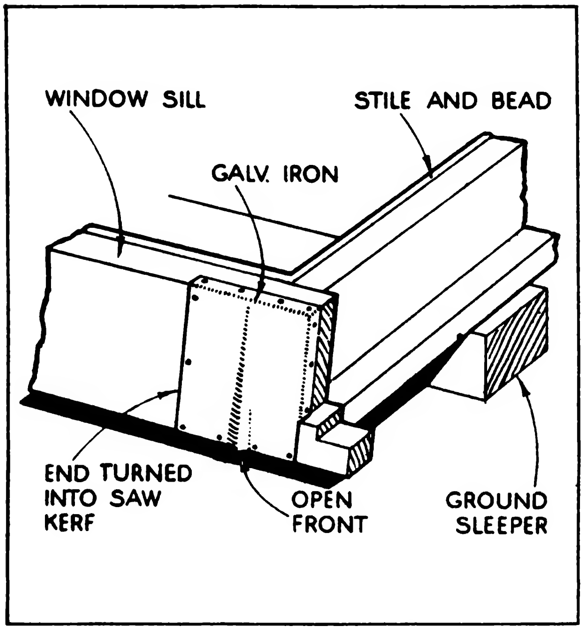


Fig.1 Flashing Fixed under Sill.

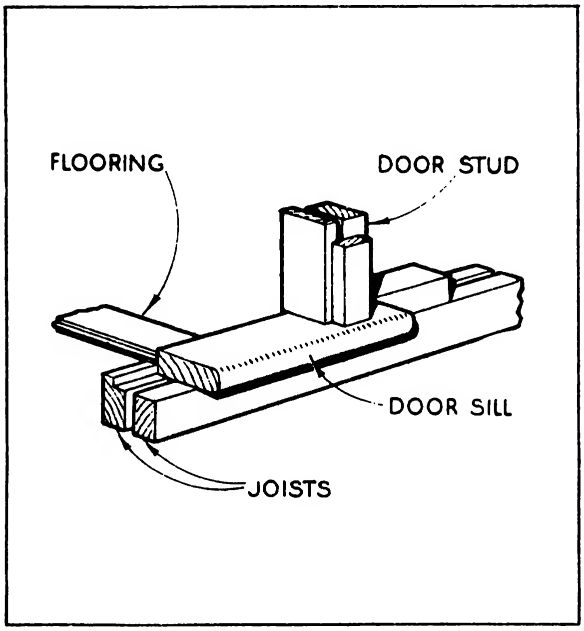


Fig.2 Method of Fitting Door Sill.

ERECTING THE DOOR JAMB LININGS.

The sill at the entrance door has a projecting rounded edge and is of thicker material than the flooring boards and this makes it necessary to cut away part of the floor joists to fit it in place, as shown in Fig. 2. The door jambs are wedged from the studs into a plumb line and the $2\frac{1}{4}$" x $1\frac{1}{4}$" stops are nailed to their outer edges. These make stops for the weatherboards as well as architraves. The top edge is covered with a strip of metal flashing.

Architraves are frequently specified in wider material to give opportunity to have larger wedge room between the studs and the jambs. This is more necessary when the studs are of greater length. The jambs of the partition door are fixed when their turn comes.

The door stops are only tacked in place, or put aside until the door is hinged.

THE PLINTH.

The top edge of the plinth forms the base for commencing the weatherboards and must make one continuous level around the outside walls. It is fixed at the height shown in the plans with all joints at corners and extensions of timber lengths made with 45^{o} mitre cuts.

WEATHERBOARDING.

Before weatherboards can be fixed on the wall, a gauge of some kind must be made to determine the width of board that will be exposed below the one that overlaps it. Boards are approximately $6\frac{3}{4}$" wide and the overlap is approximately $1\frac{1}{4}$".

The weatherboard stops are used to set out as storey rods. The boards are spaced out equally on them in a number calculated on the basis that $5\frac{1}{2}$" is the maximum width that a board can cover. A section of lapped weatherboards on a wall is shown in Fig. 1, also a wooden gauge which is cut from scrap material, and which is used to hold up the weight of the board while it is being marked and fixed.

Take the front wall as that side which is required to present the best appearance on completion. Mark its height on one pair of stops and space out equally the bottom edges of all the weatherboards, squaring the lines on both edges of the stops. These bottom edge lines are also marked on the stops of the high back wall, continuing the same spacing as far as the extra height demands.

A good procedure when fixing the weatherboards on a job is to complete one end and follow on across the front, making the boards fit between stops and joinery frames as they are met. The advantage of boarding an end first is found in the greater rigidity that is given to the weatherboard stops when fitting the front boards to them.

In all the walls the bottom weatherboard is fixed with firring behind it to make the slope of its face the same as those above, as shown in Fig. 2.

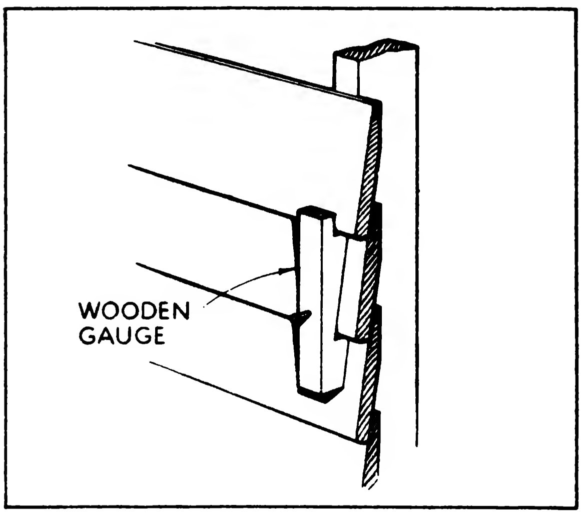


Fig. 1 Gauge used for Fixing Weatherboards.

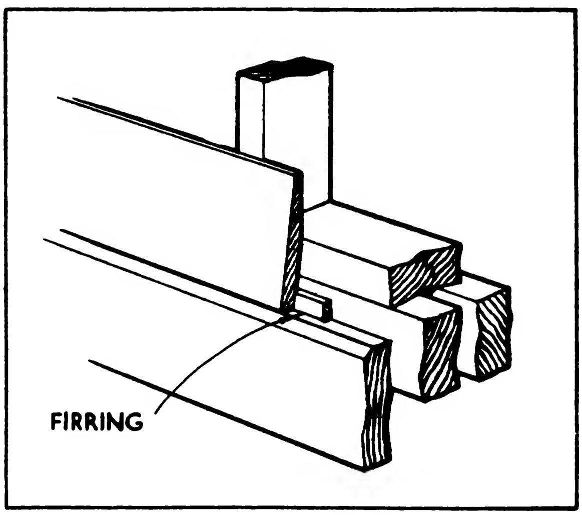


Fig. 2 Bottom Weatherboard Fixed with Firring.

Weatherboards are occasionally made in greater widths than the standard 7". It has been found that a seasoned board 7" wide has only a reasonably small shrinkage in summer from its width in winter. Even that small skrinkage is enough to split a board if it is fixed to the stud on its two edges. Nails must therefore be driven through the overlapping board close to its bottom edge without going through the board under it. The correct nailing point is shown in Fig. 3.

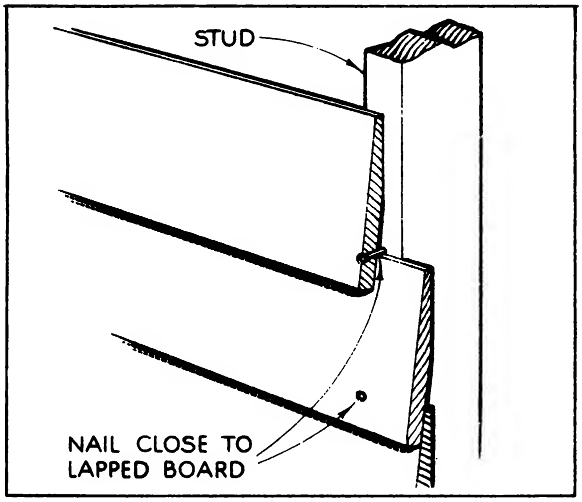


Fig.3 Correct Nailing Point for Weatherboards.

Ends that butt against stops should fit in place from the first saw cut. This can only be achieved by accurate marking and cutting. A marking templet, made as shown in Fig. 4, is better than just sighting the rule with the stop and marking from the edge of the rule.

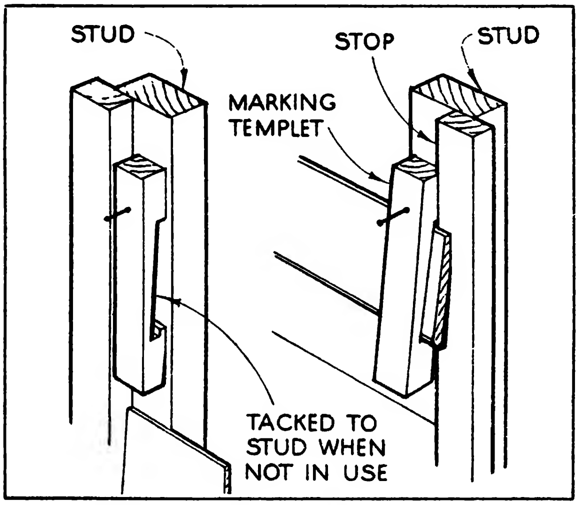


Fig. 4 Method of Using Marking Templet.

A misfit can often be traced to the fact that during marking the back of the board is flat against the stop instead of giving it the tilt it will have when it has been cut and tried against the stop.

When weatherboarding is fixed to the limit of hand reach above the ground, planks on saw stools usually make the first scaffold. Above that height, if trestles are not available, a simple scaffold can easily be built on brackets. The bracket usually carried as part of a builder's equipment, is shown in Fig. 5.

Odd lengths of scantling with their feet resting on the ground against pegs, are used for shores. The bracket must rest against the wall directly opposite a stud. The shore must not be so long that it makes a low slope from the ground to the wall, or the weight will be forced so strongly against the wall that the bracket will slide across the weatherboards and damage them.

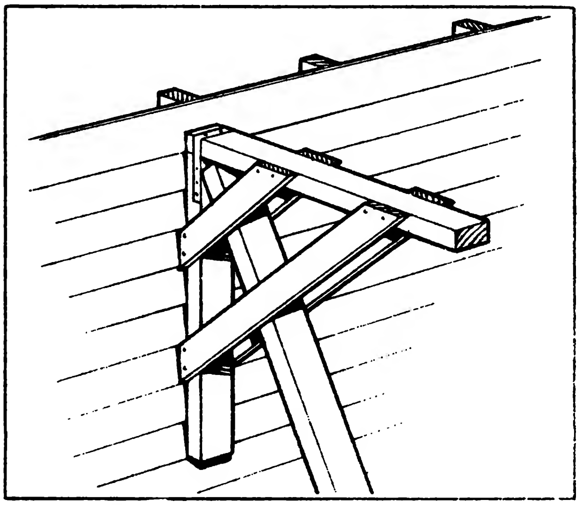


Fig.5 Scaffold Bracket Erected against Wall.

BARGE BOARDS.

The barge boards of a weatherboard building that has a roof line of low pitch require firring pieces behind them to build them out to a straight plumb face line. The barge boards are made long enough to form a stop for the spouting and fascia. The ends are cut to a plumb line as shown in the plans. The top edges are capped with galvanized iron ridging.

SPOUTING.

Spouting is fixed on its own special metal brackets which are spaced out to nail on the rafters. The bottom of the spouting rests on the top edge of the fascia, as shown in the cross section on the plans.

CORRUGATED IRON.

Roofing iron, by being corrugated is stronger and more able to resist weights than flat sheet iron of the same gauge. The corrugations give drainage channels and high lines for water proof nailing, and they serve to gauge the lap of adjoining sheets. The amounts of lap are known as "one and a half corr", $1\frac{1}{2}$c, or "two corr" 2c. The width of a standard sheet is shown in Fig. 1 Adjoining sheets with $1\frac{1}{2}$c cover approx. 1' $10\frac{1}{2}$", and those with 2c, 1'9".

Special nails and screws for iron are shown in Fig. 2. The nails have points that drive directly through the iron. Screws require holes made through the iron with the "prick punch" or a very big nail. The top ends of the bottom corrugations must be turned up to prevent rain being easily driven into the wall by the wind. The junction of the walls and the roof is capped by rolled ridging which is nailed through one flange to the wall and through the other to the roof battens, (Fig. 3).

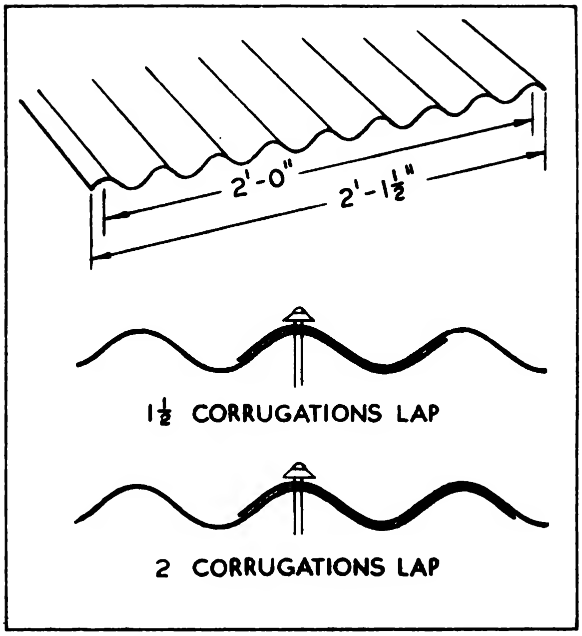


Fig.1 Standard Laps of Corrugated Iron.

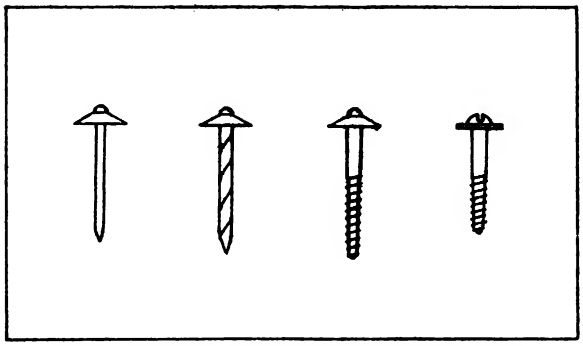


Fig.2 Special Nails and Screws for Iron.

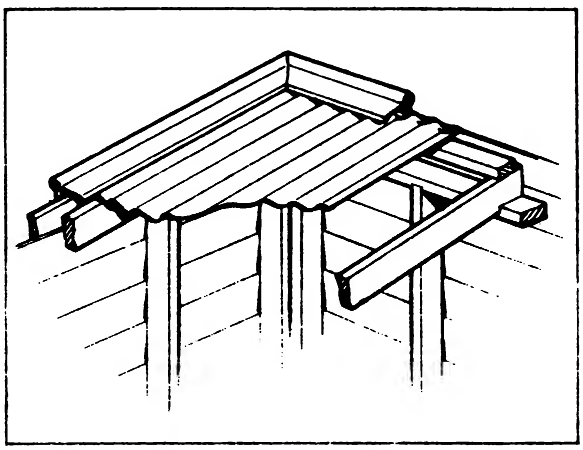


Fig.3 Method of Fitting Rolled Ridging.

FLOORING.

Timber decking or other support will be required to support the poured concrete until it sets in the drainage slab provided in one corner for the gas copper. Flooring boards are machined to join with tongues and grooves. A sufficient number of boards of one length is often obtainable in a length to fit the room with very little docking off and waste.

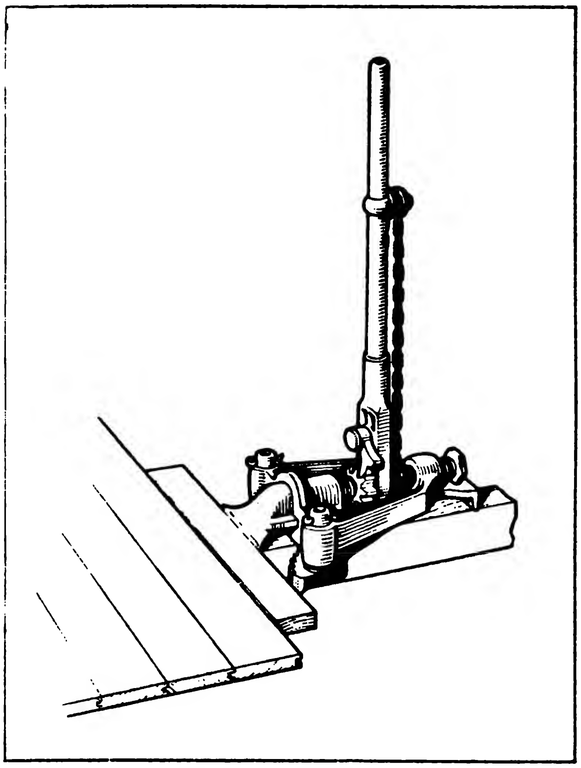


Fig.1 Floor Boards Squeezed Together by Cramp.

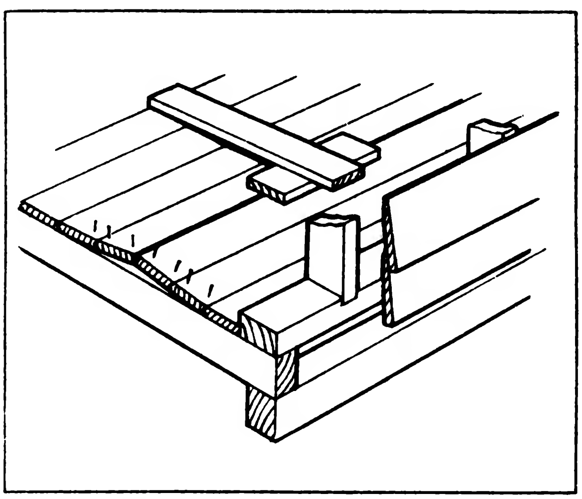


Fig.2 Method of Folding In the Last Boards.

Pick out a straight board as the first to be laid, cut off its tongue, and holding that edge tightly against the wall plate, nail the board down to all the joists. One nail is driven home about $\frac{3}{4}$" from the wall plate and a second nail is left driven almost home hear the grooved edge. The slackness of the second nail allows a little more freedom for the next board to slip its tongue into the groove.

Three or four boards are now laid as tightly against the first one as they can be pushed by hand in preparation for cramping together. A straight piece of scantling that has square edges is laid on the joists beside the outside board and floor cramps are used to squeeze the boards tightly together, as shown in Fig. 1.

Double nail the boards to all the joists at approx. $\frac{3}{4}$" from the edges, leaving the last row of nails only part driven, as in the case of the first board. The cramps are then removed and the process repeated.

A greater number of boards may be cramped up in the following rows. The smaller number used at the beginning is to make a safe line across the joists. The last three boards are "folded in" at the one time, as shown in Fig. 2. The width they occupy is measured and the final board cut accurately, for they are most difficult to lift if, when fitting them, it is found that the width of the boards is too great.

THE PARTITION.

The partition is of light construction and is erected between the floor and the roof. The bottom plate is set out with the door opening where shown in the plans, and is prepared by cutting out the housings for the studs and with its ends to fit over the plates of the long walls, as shown in Fig. 1.

Tack the brace in position and after scribing the lines, house it into the plate and cut the top end into the rafter. Nail the plate to the floor and the brace to the studs and to the rafter. The studs are cut to fit around the brace and the rafter. The trimmer is nailed in place when the studs are being fixed.

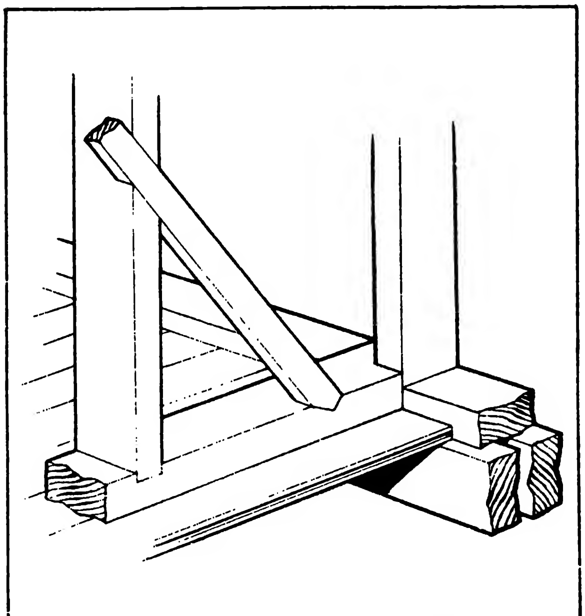


Fig.1 Partition Wall Frame.

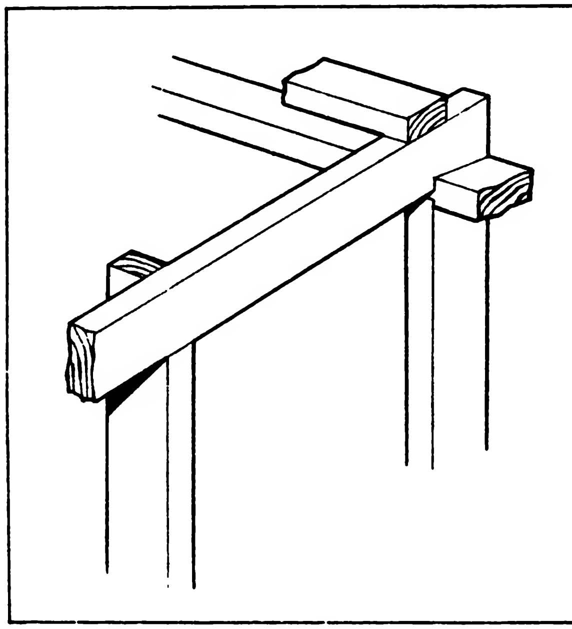


Fig.2 Top End of Partition Studs.

CONSTRUCTING WALL FRAME FOR HORIZONTAL LINING

The brace is tacked up in position where it will clear the door height and give as flat a pitch as possible, and after scribing its edge lines, it is housed into the bottom plate and rafter. The bottom plate and brace are then nailed in place.

The studs are cut individually, having their lengths scribed from the top and bottom of the rafter and the cross housings of the brace scribed from it. Near the top ends of the door studs, housings must be provided for the head trimmer which is nailed in place before fixing these two studs and the three erected as one piece. The top fixing around the rafter is shown in Fig.2, and the whole face of the wall must provide one vertical fixing line for the lining that follows.

Skew nailing the studs to the rafters gives fixing that will more rigidly withstand the hammering that will occur when the lining boards are nailed to them.

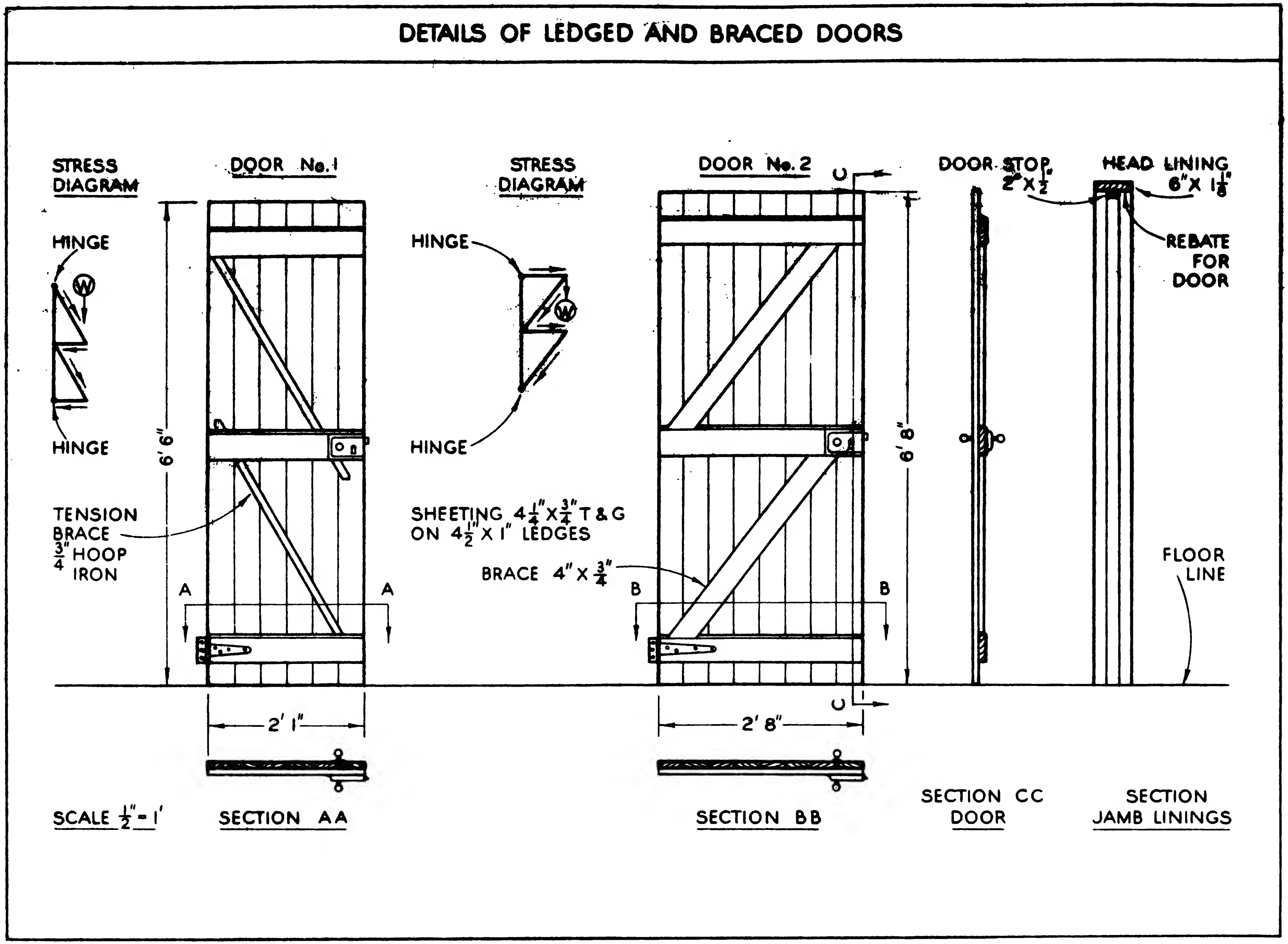


Fig.1 Details of Construction of Ledged and Braced Doors.

LEDGED AND BRACED DOORS.

Two methods of bracing are shown in the detail drawing in Fig. 1. Door No. 1 has hoop iron, that keeps the closing edge of the door from drooping by taking its weight diagonally across to the hinge side. The brace is subject to a tension strain. Door No. 2 is braced with timber, that forms with the ledge above it, two sides of a triangle like a bracket. The ledge is subject to a tension strain and the brace is subject to compression. It is always of assistance to observe the strain that the parts will take and shape the joints to take their parts with the best results.

The door sheeting require cutting to length with a small allowance for trimming off to line when completed. Chamfer the matched T. & G. edges to make Vee joints between the boards, and smooth off the backs of the boards. Weather the top edges of the ledges with a flat bevel to assist in throwing off rain or dust. The sheeting and weathered ledges are shown in Fig. 2.

Door No. 1 is constructed by setting out on two outside boards, the heights for the ledges and laying all the sheeting in order, with back up, in a corner on the floor where the wall plates will keep the ends flush and to a square line. Assuming that no bar cramps are available and that a few extra nail holes in the floor are allowable, the door sheeting can be wedged up as shown in Fig. 3.

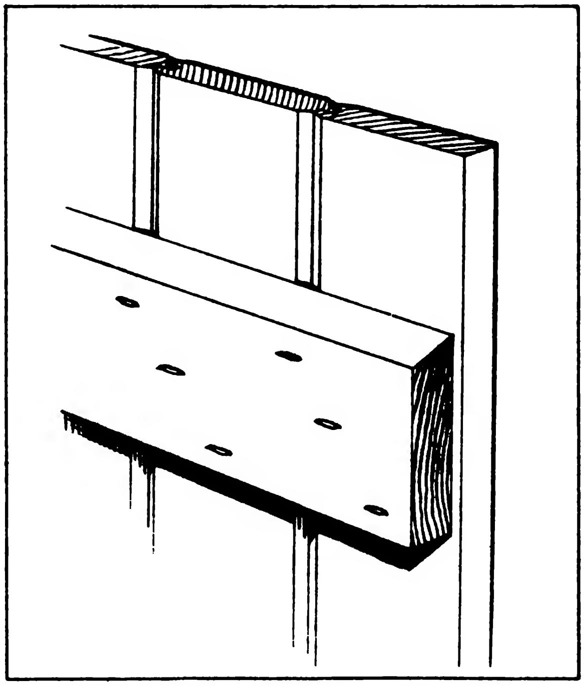


Fig. 2 Detail of Nailing in Door Ledge.

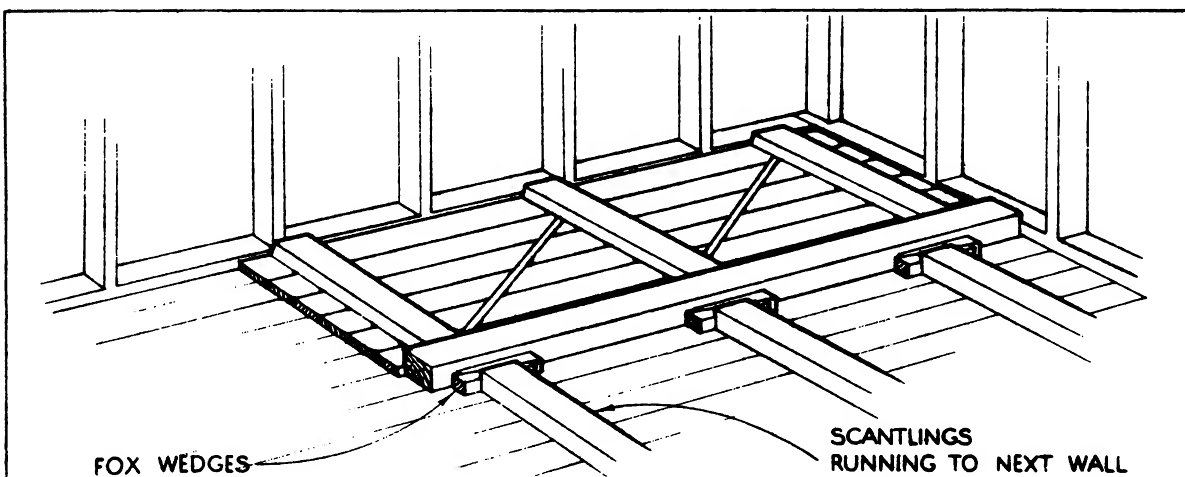


Fig. 3 Method of Cramping Door Sheeting.

To prevent the boards from jumping out of place it is advantageous to have a piece of heavy material laid across them, close to the wedging line. The hoop iron braces are nailed on with the lengths stretched as tightly as possible, and diagonally between the two outside boards, and the ledges are also screwed or securely nailed to the outside boards. The nailing is continued with a row of $1\frac{1}{2}$" nails along the ledge.

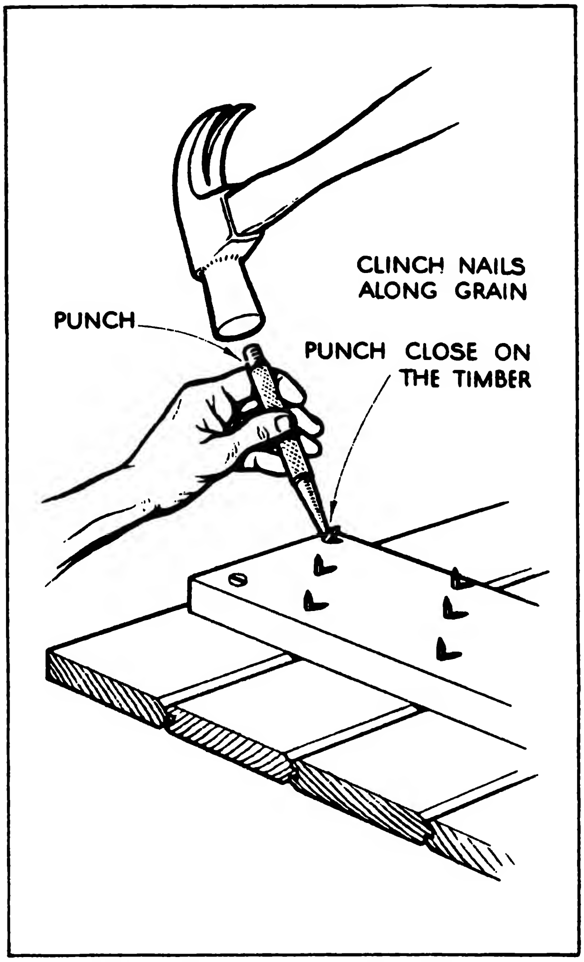


Fig.4 Method of Clinching Nails.

The wedges are now released, the face of the door is turned upwards, and the sheeting is fixed with 2" nails staggered across the width of the ledge.

Some protection should be given to the floor with a few short ends of flooring between it and the ledge, so as to take the points of the 2" nails as they are driven through the ledge and their heads are punched below flush.

The door is again turned over and the projecting points of the nails clinched with a hammer and a nail punch, as shown in Fig.4.

Door No.2 is constructed in much the same manner, the order of operations being altered only by the cutting and fixing of the timber braces after fixing the ledges, instead of before, as was necessary with the hoop iron.

Keep an eye on the position that the lock handle and key holes will occupy when bracing and nailing so that only timber will be encountered when the lock is being attached.

FITTING AND HANGING SINGLE DOORS

Ledged doors are usually hung with Tee hinges, the size of the hinges being specified. If butt hinges were used the screws would be driven into the end grain of the ledges and would not hold securely.

The procedure for fitting and hanging single doors is as follows:-

Shave off and sharpen a pencil so that it will mark a line barely $\frac{1}{8}$" from its flat side. Cut a short block having the thickness equal to the required floor clearance, say $\frac{1}{2}$" Correct any twist in the edge alignment of the jamb linings. Part drive two nails in the upright jambs for temporary stops when the door is fitted.

Compare the width of the door with the opening between the linings and as guides to keeping the door central, mark it clearly near the floor line with short pencil lines showing its half extra width at both edges. Hold the door against the opening and keep the pencil line showing at the lining. Wedge up the door to make its V joints parallel to the lining.

Scribe lines all around the door from the jamb linings and the floor clearance block , and stand the door aside for sawing the top and bottom lines as shown in Fig.1. Wedge the door in the floor block and plane off the edges as shown in Fig.2. Test the fitting with the door in place against the temporary stops.

Hang the door by screwing the hinges on the door ledges and then on the linings. Fix the lock and its staple. Shut and lock the door, and then replace the temporary stops with timber, leaving a little extra clearance towards the hinged edge.

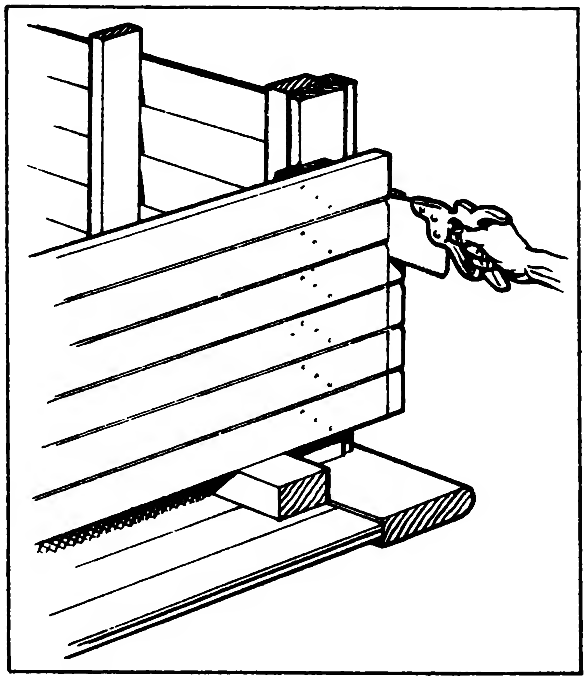


Fig.1 Sawing the Door to Correct Length.

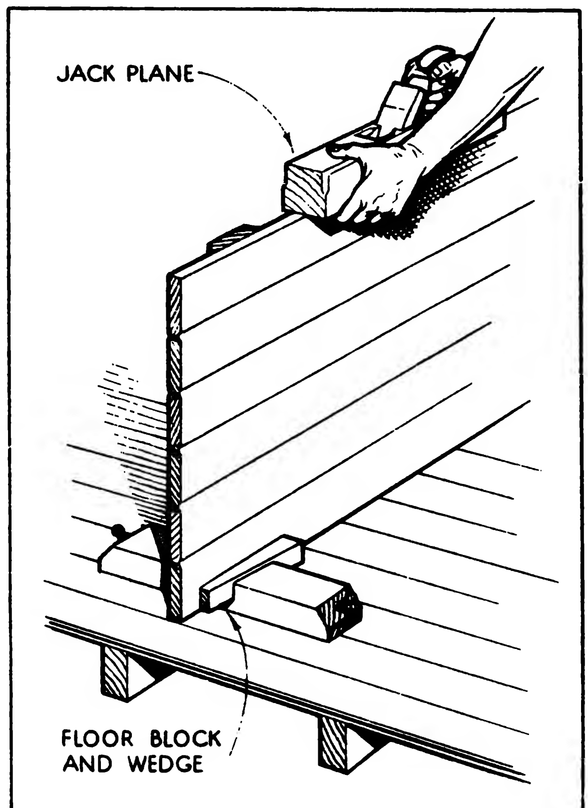
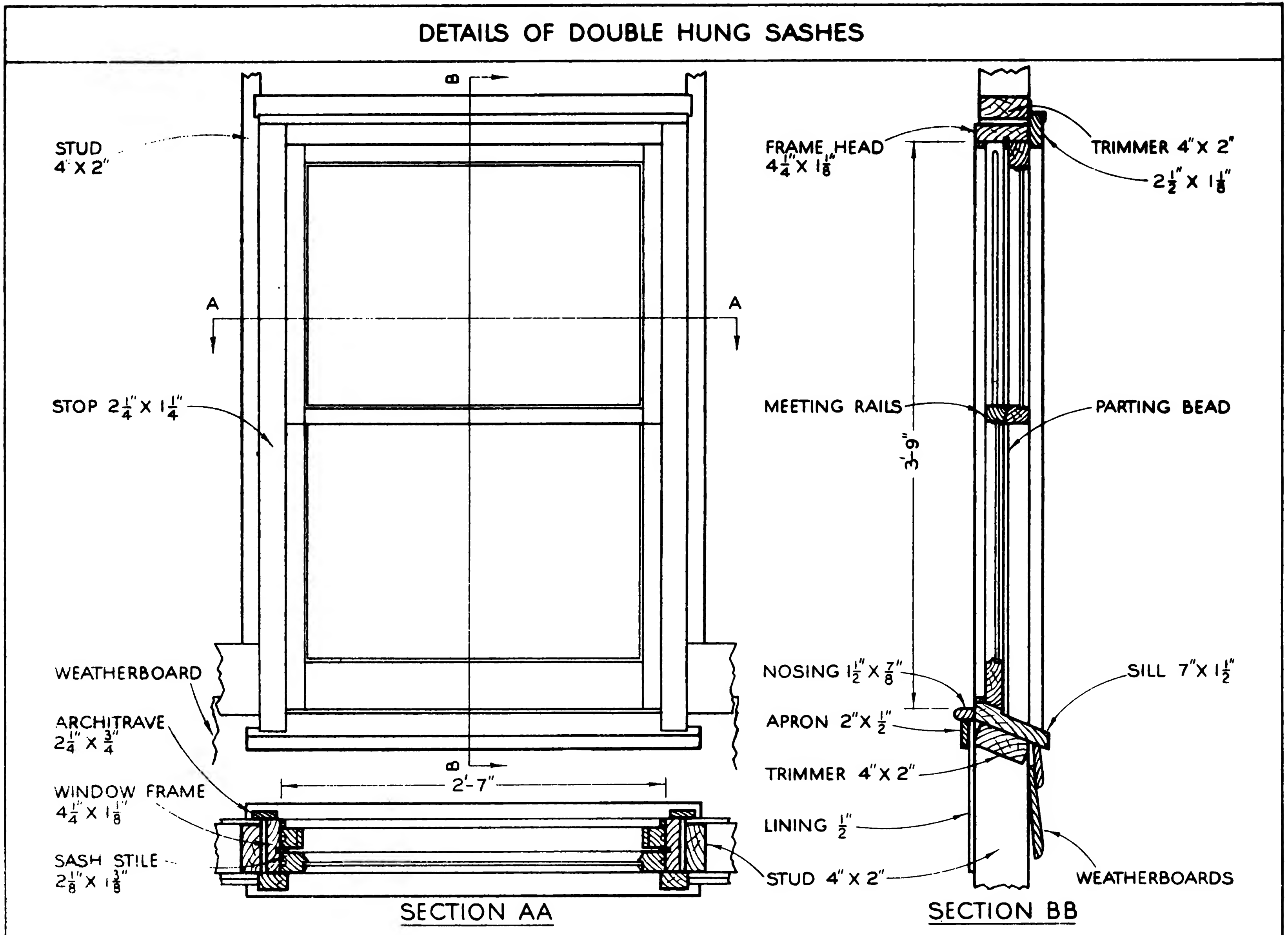


Fig.2 Method of Holding Door while Planing.


DETAILS OF DOUBLE HUNG SASHES
STUD 4" X 2"
STOP $2\frac{1}{4}$" X $1\frac{1}{4}$"
WEATHERBOARD
ARCHITRAVE $2\frac{1}{4}$" X $\frac{3}{4}$"
WINDOW FRAME $4\frac{1}{4}$" X $1\frac{1}{8}$"
SASH STILE $2\frac{1}{8}$" X $1\frac{3}{8}$"
A
A
B
B
2'-7"
SECTION AA
FRAME HEAD $4\frac{1}{4}$" X $1\frac{1}{8}$"
TRIMMER 4" X 2"
$2\frac{1}{2}$" X $1\frac{1}{8}$"
MEETING RAILS
PARTING BEAD
3'-9"
NOSING $1\frac{1}{2}$" X $\frac{7}{8}$"
SILL 7" X $1\frac{1}{2}$"
APRON 2" X $\frac{1}{2}$"
TRIMMER 4" X 2"
LINING $\frac{1}{2}$"
STUD 4" X 2"
WEATHERBOARDS
SECTION BB

DOUBLE HUNG SASHES.

A window specified to have "double hung sashes" requires two sashes in the height of the frame. These are generally referred to as a "pair of sashes". The detail drawing in Fig. 1 shows the complete sashes and frame. The sashes are made very closely to the correct width and the stiles are grooved for balances during manufacture in the joiner's shop. The pair of sashes will have a uniform size in glass and the bottom rail is always wider than the top rail, making the bottom sash stand higher when placed alongside the top one.

The "Unique" balance which has been specified, takes the place of the older fashioned weights and cords, which needed suspending in a box frame over sash pulleys.

PREPARING THE SASH FOR FITTING.

Check the level of the frame sill, and if it is impossible to adjust any error make a note of the lower end and the dimension of the fall. The error in the level of the sill if of noticeable size will require larger sashes to allow the sash rail to be made on level lines.

Measure the height of the frame from under the head to the top of the sill at the outside line of the bottom sash, where 3'9" is a figured dimension on the detail drawing in Fig. 1.

Measure the size of the sashes when the meeting rails overlap one another and compare the two heights. The sash size should be greater, and the difference in measurements shows just how much can be divided between the pair while fitting them for height to the frame.

Prepare the frame by removing from the stiles and sill all the beads that form the running channels for the sashes. Use a wide chisel to lever them out as shown in Fig. 2. A narrow chisel often damages both the bead and the frame. Put the beads aside to the right and left hand sides so that they can be returned easily.

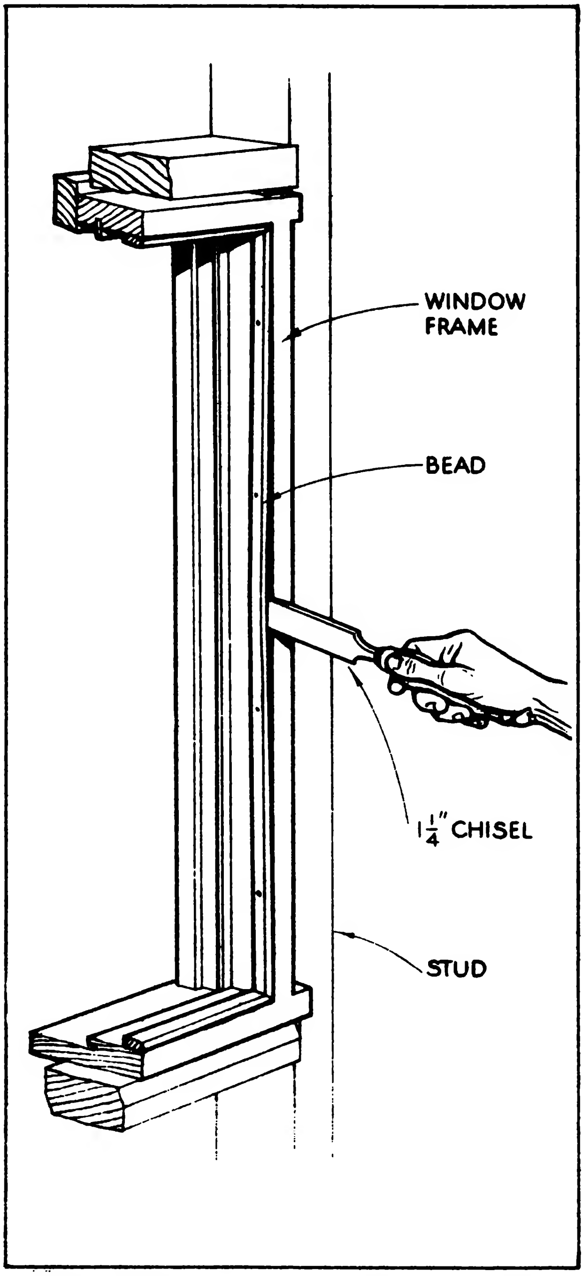


Fig. 2 Method of Removing Beads from Frame.

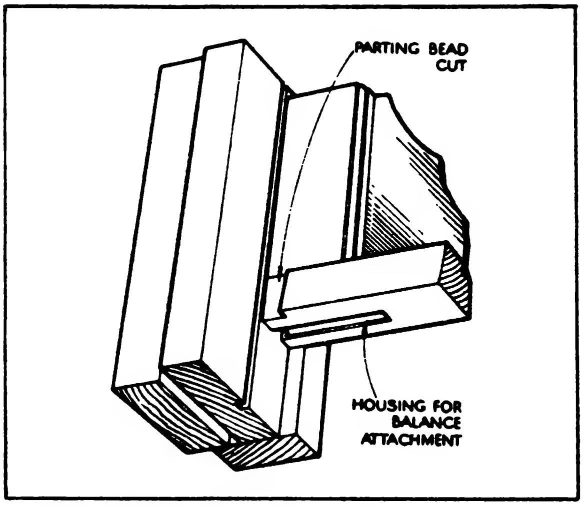


Fig.3 Housing in Meeting Rail of Top Sash.

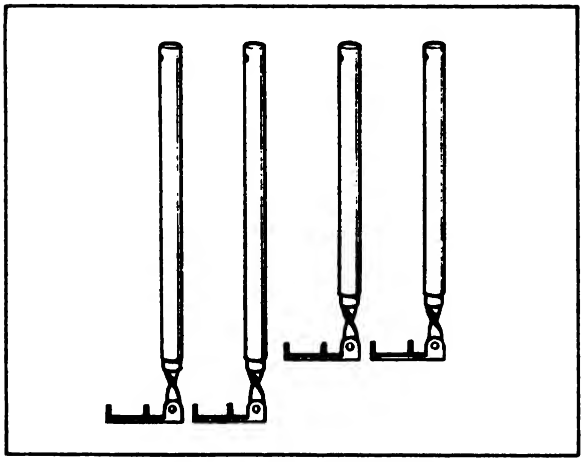


Fig.4 Set of Balances.

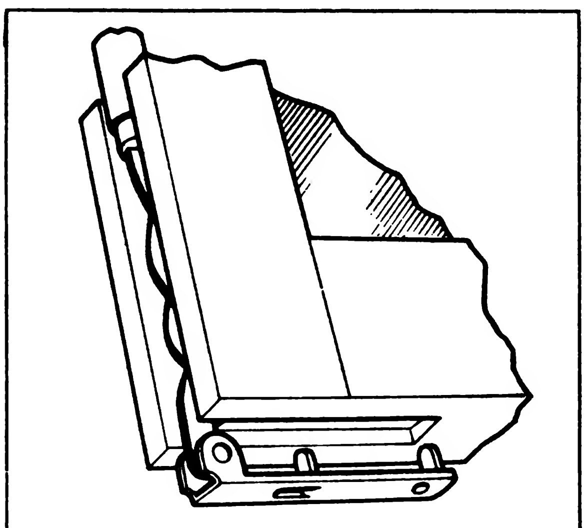


Fig.5 Method of Fitting Balance to Sash.

FITTING THE TOP SASH

The top sash is the first one to be fitted in the frame. The sash must have about $\frac{1}{8}$" clearance in width from the frame to allow its free action when sliding up and down. One great point to watch during fitting is to see that the meeting rail is level when the sash is pushed hard up against the top of the frame. To see if the line of the meeting rail is level, check with other level lines in the room. The spirit level should be used to make sure that the line of the rail is correct.

A saw stool with an internal V cut in its end is a very good means of supporting the sash while its edges are being planed off to size.

The meeting rail must have its projecting bevelled edge neatly notched at both ends to allow movement of the parting beads, and housings must be cut for the balance attaching lug, as shown in Fig.3.

Complete sets of balances, as shown in Fig.4, are supplied by the manufacturers, including all small parts and screws. The balances for the bottom sash have the extra length that they require and are easily distinguished from the top ones.

Lower the sash in the frame and set in on the sill. Put the parting beads back in their respective grooves. If one does not hold tightly in its groove, fix it with a few brads.

Make sure, by trial, that the sash will run easily up and down its channel. Then attach the balances and stops. The housings for the balance attachment are cut out as shown in Fig.5

INSTALLING THE TOP BALANCES.

Drop the sash attachment on one of the short balances into its groove. Turn the seam of the tube against the jamb and keeping the tube on the centre line where the sash will lift, nail it to the frame, right up at the top as shown in Fig.6.

Repeat these operations at the opposite side of the sash. Raise the sash up to its highest position and either prop it up with a stick or hold it up with nails part driven into the frame.

Stops are now tapped down on the sill in the bottom corners of the running channels and are screwed to the frame, as shown in Fig.7. These stops not only stop the sash but their quarter round shape guides rain water out of the corners across the sill.

Adjust the balance by turning the sash attachment to the left. Screw the spiral rod in the balance to the left until the attachment is flush with the bottom of the sash. Try the balance by holding the attachment in the hand so that it will not revolve, pull it down about half the height of the sash, and then allow it to rise without turning. Make more turns to the left if necessary, until the sash rises by its own power.

Three or more left hand turns are required before driving the pronged attachment into the sash to hold it in place whilst the second balance is adjusted and driven into the underside of the rail. Run the sash up and down to check it for balance and adjust with fewer or more turns as required. When the weight of the sash is balanced the screws are used to fix the attachment and the top sash is temporarily held up with nails.

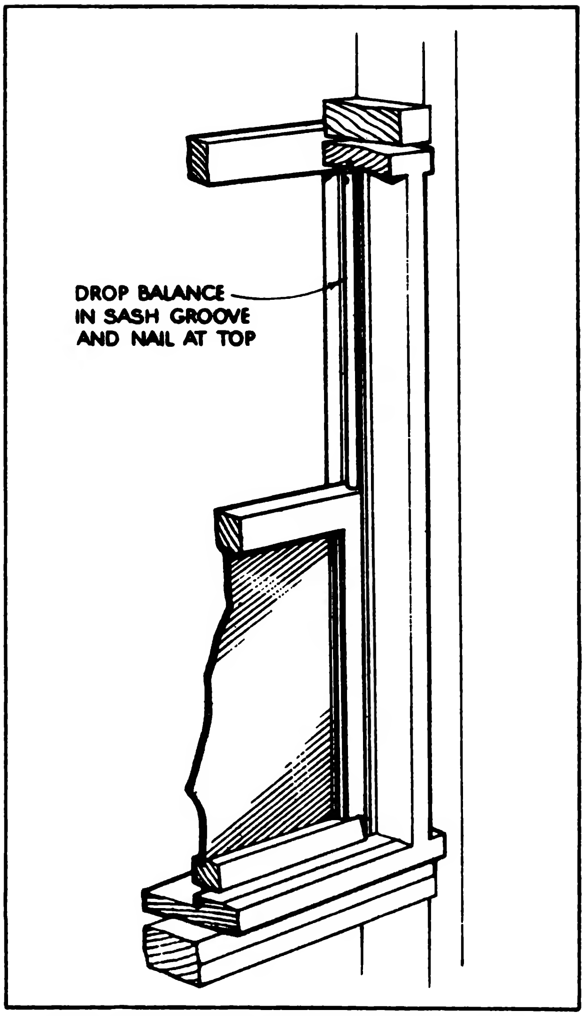


Fig.6 Method of Fixing Balance to Frame.

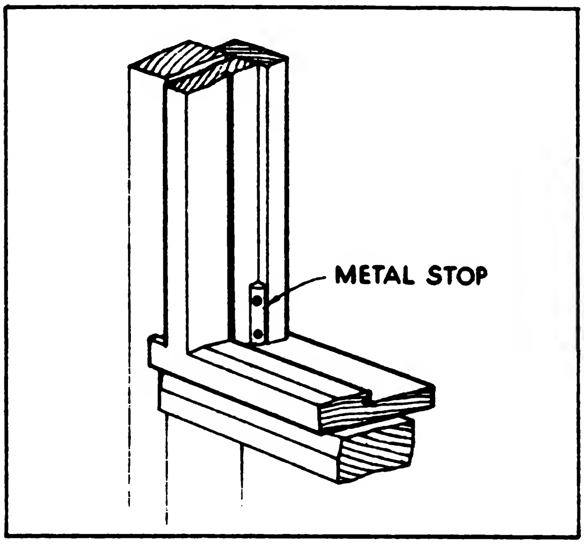


Fig.7 Method of Fixing Stop for Top Sash.

FITTING THE BOTTOM SASH.

Measure the height of the bottom sash by cutting a lath to the sill bevel and putting on it a square line, as shown in Fig.8, or by taking the size on the rule between the top meeting rail and the sill. Try the sash in the frame and see that its width is correct. Make its meeting rail parallel with that of the top sash by wedging up a low end from the sill. Note the difference in heights and scribe it in several places on the bottom of the sash, as shown in Fig.9.

Remove the sash from the frame, apply the lath or the rule measurements, check the size with the scribed points, cut the sash to fit the sill, and notch out the meeting rail for beads. Make the inside bottom edge slightly round to lead the sash past the staff bead where it is being closed. The height is not all the fit required. Sometimes a shaving must be taken from the meeting rail bevel. Check all around the sash, then cut out housing for the balance attachments.

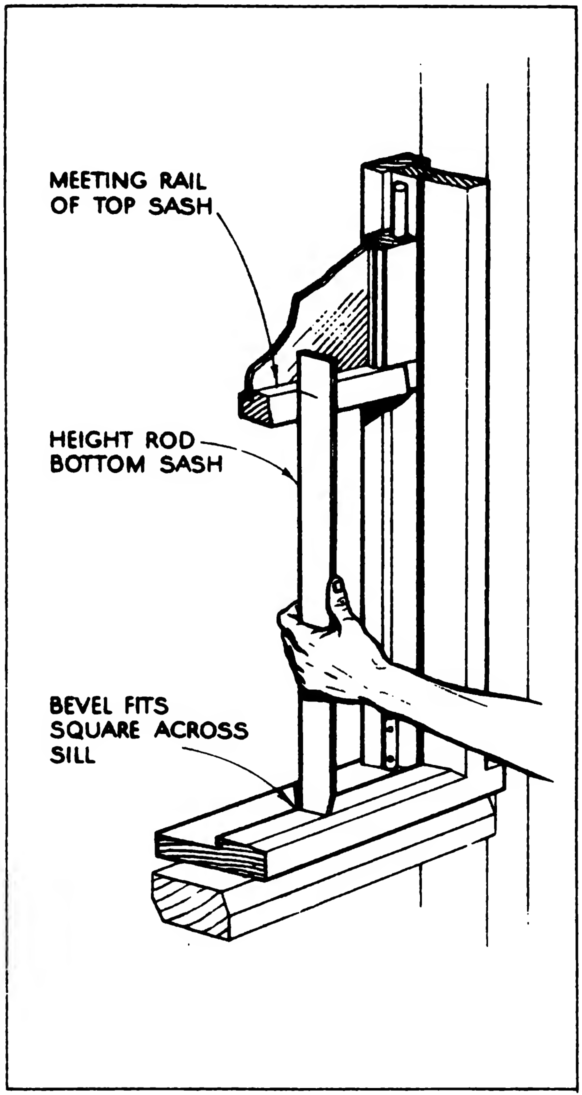


Fig.8 Measuring the Height of the Bottom Sash.

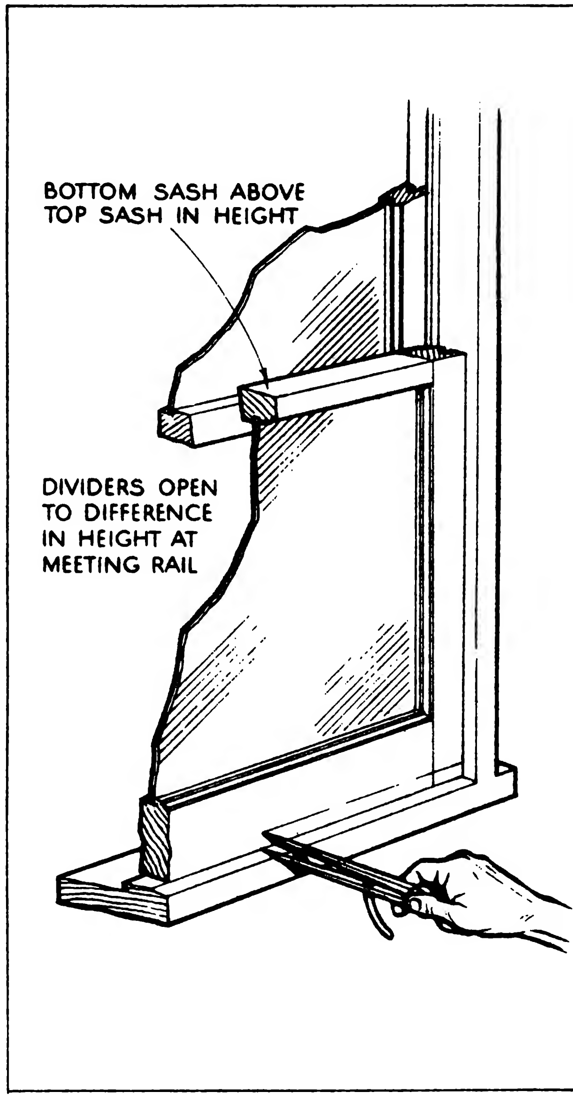


Fig.9 Scribing Bottom Sash to Sill.

REFIXING THE STAFF BEADS.

The staff or stop beads have now to be refixed in the frame.

Close the bottom sash, hold the lower bead against it and lightly nail the bead to the sill. Make a trial opening and shutting movement of the sash to test the line of bead before opening the sash well out of the way and finally nailing the bead to the sill.

When fitting the long upright beads, they must be bowed out as shown in Fig. 10, so that the bottom ends can be steered into place and make tight fits in the mitres.

Treat the long beads like the short ones, with trial movements of the sash before nailing them in place. Do not nail the long beads at short distances from their mitred ends, as this is a great hindrance if later on the beads have to be taken out.

FIXING SASH FASTENER AND LIFTS.

To fit the sash fastener, as shown in Fig. 11, open the sashes so that the meeting rail of the top sash is within easy working reach and while keeping the fastener as close to the edge of the rail as possible, screw on the staple portion midway between the stiles.

Close the two sashes and with their edges held closely together, adjust the round wedge under the staple with an almost complete turn and screw it to the bottom sash.

Sash lifts of the hook type, as shown in Fig. 11, are generally attached in pairs to the bottom rail of the sash to give double handed action when lifting the sashes. Keep them as wide apart as possible.

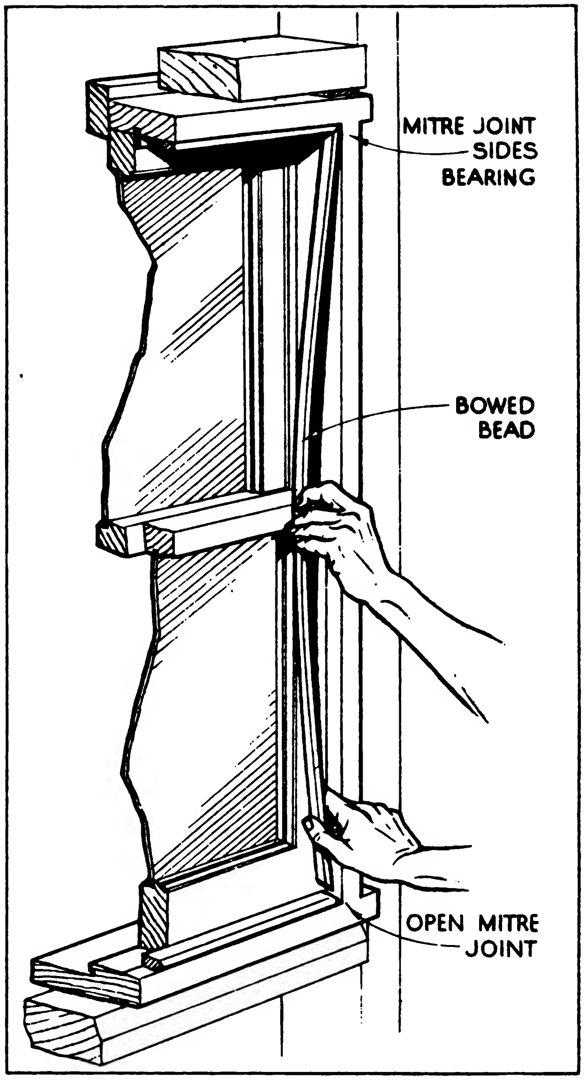


Fig.10 Method of "Springing In" Long Bead.

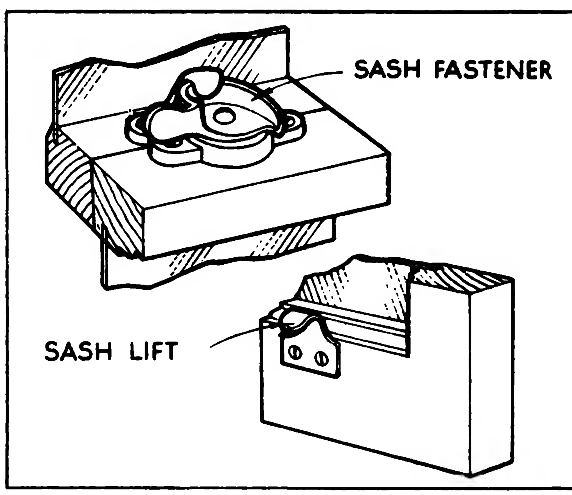


Fig.11 Sash Fastener and Sash Lift.

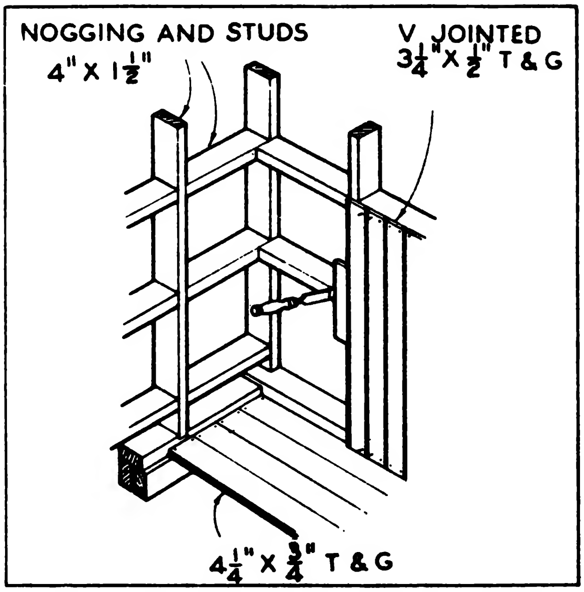


Fig.1 Method of Levering Boards Together.

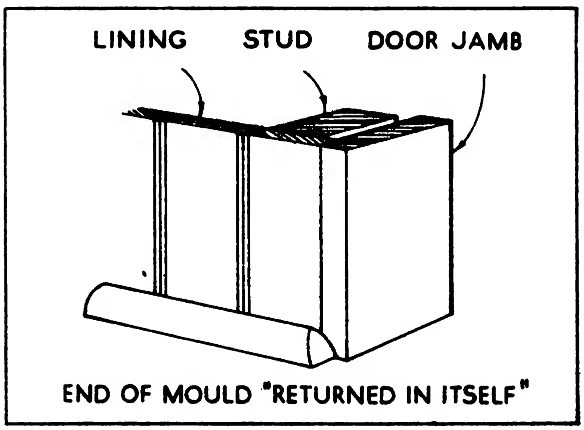


Fig.2 Termination of Mould at Door End.

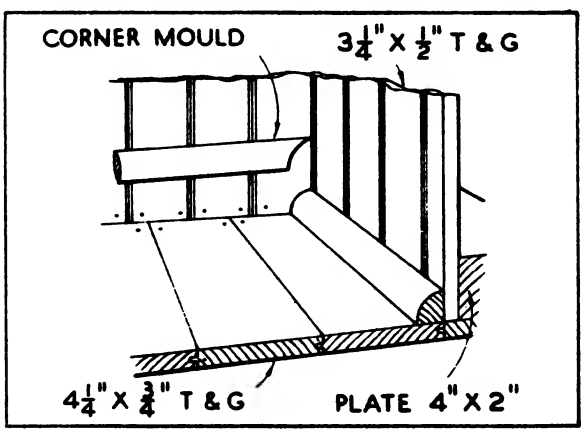


Fig.3 Method of Fitting Quad Moulding.

NOGGING.

Nogging is neatly cut to fit between the studs, and is nailed to them in level lines where it is shown in the plans. It forms fixing for the upright lining of the dado.

LINING THE DADO.

Square cut the lining boards to a standard length. The "quad" mould will cover the joint between the floor and the boards. At the height of their top ends stretch a chalk line along the wall to indicate the level.

Test the joints occasionally to see that they are keeping a plumb line so that when the corner is reached the last board will not be wedge shaped. A board is squeezed tightly against another by levering with a chisel, as shown in Fig. 1.

When all the lining is fixed, wedge shape blocks are cut and fixed on the top nogging and the capping is cut around all the studs bevelled on the edges and fixed in place.

The quad mould is nailed to the floor in the right angle junction between the wall lining and floor.

The first length selected for fixing is always the one that has its end joints most readily observable from the most used part of the room. Its ends are square cut against intersecting walls or an outside end is "returned in itself", as shown in Fig. 2.

The lengths that follow on make "scribed" joints with the preceeding one, as shown in Fig. 3. The long lengths are only "tacked" in place so that they can be lifted readily, for re-cutting the mould between the legs of the fittings.

MAKING A STAND FOR WASH TROUGHS.

The stand is made high enough to bring the top of the troughs to approximately 3 ft. from the floor.

Measure the troughs on the job. One manufacturer makes them a different size from another. Dressed timber nominally 3" x 2" in section, is cut to make the frame and the legs. The frame is nailed at the joints and to the studs of the wall, and the legs are nailed to the floor as shown in Fig. 4.

When levelling it up, make the temporary support for the back rail either with cleats or on part driven nails, so that the height is easily adjusted before final nailing.

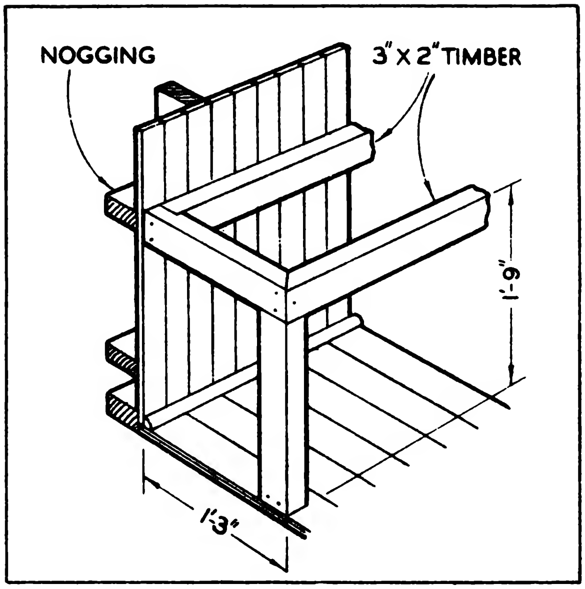


Fig.4 Construction of Stand for Wash Trough.

FIXING HORIZONTAL LINING BOARDS.

Horizontal lining boards are nailed directly to the studs. The boards should be fixed with tongues up, otherwise if the groove is up it opens and collects dust or water.

The boards are prised together on the stud with a chisel during fixing. Butt joints are made along their lengths and against joinery. Fig. 5 shows how to use the elbow of the arm which controls the chisel so that the lining board is kept against the studs until the first few nails make it secure. The top nails of the boards are not finally driven home until another board is fixed above it. This allows a little more freedom of entry between the tongues and grooves.

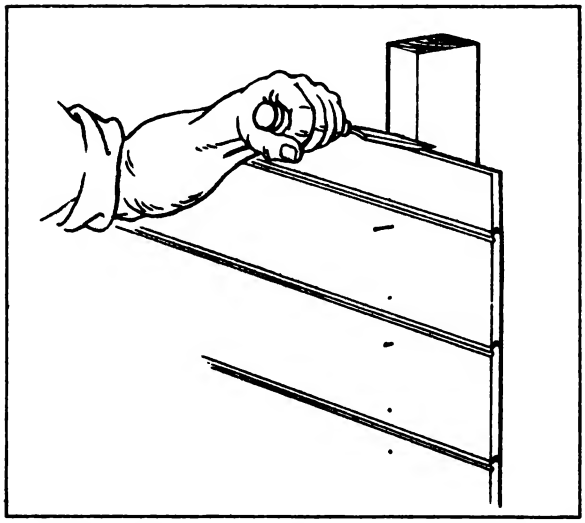


Fig.5 Method of Prising Boards Together.

At the corners a batten is nailed to the corner stud through the lining, as shown in Fig. 6, to provide nailing for the next wall, and the joint line is covered with a quad. At the corners the boards on one wall are carried through the thickness of the junctioning wall, and a batten is nailed on top of them to provide nailing for the adjoining boards.

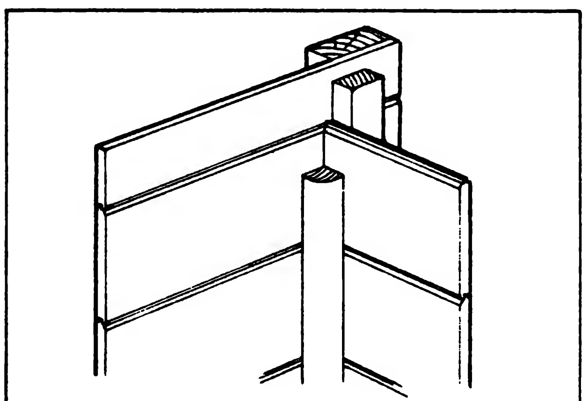


Fig.6 Corner Construction.

FRAMING UP A FLIGHT OF STEPS.

It is apparent that persons on the ground must have an easy means of access to the floor level. This might be done either by building a ramp, such as that shown in Fig. 1, or by a flight of steps. A ramp of easy rising grade requires more ground space under it and more timber in its construction than a flight of steps. A steep ramp often causes personal falls when its top surface is worn smooth and it becomes slippery under foot, especially if damped by rain.

A flight of steps is the name given to a framed up and unbroken series of steps. Every step in the series must be uniform and the flight built with good pitch. Certain figures have been developed for use as maximum and minimum sizes in setting out one step. The ratio of the sizes to one another is tested by calculation to give a constant inside small range. The figures are applied in terms resembling those given to the sides of a gable roof triangle.

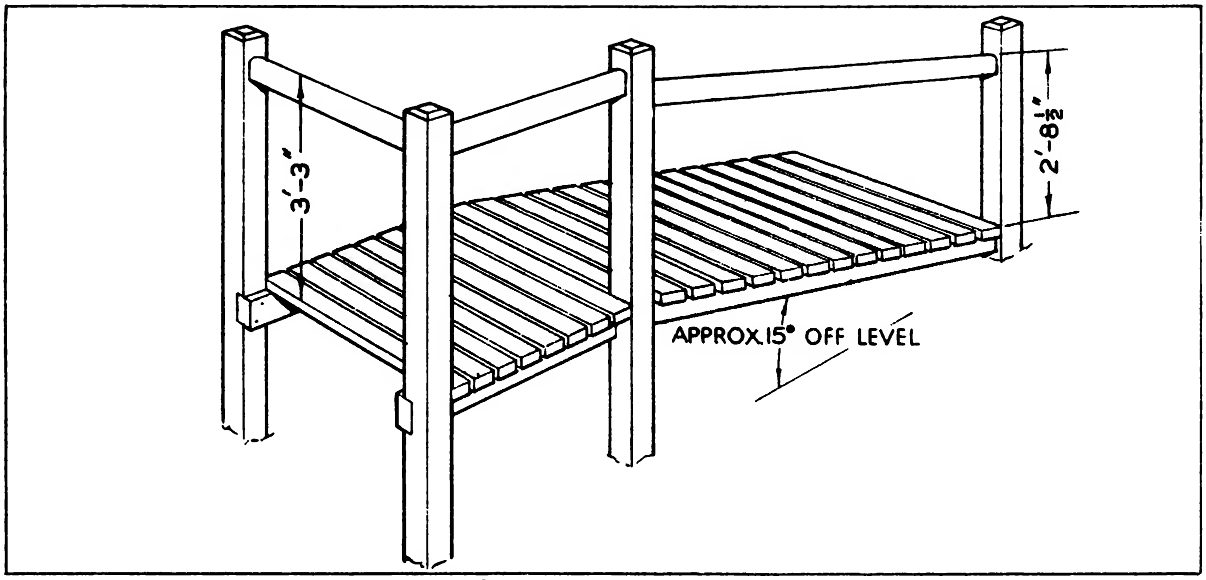


Fig.1 Construction of Ramp.

A step triangle which is also applicable to stairs is shown in Fig. 1. The base is termed the "go" or "going", because it is the level distance travelled forward when a person leaves that base and directly "goes" to the next one above. The vertical side is the "rise" and is the height moved upwards while moving from one base up to the next. The third side of the triangle is the length of string between two steps. The angle between the third side and the base is termed the "pitch bevel".

The figures for the step triangle (also applicable to common stairs), are as follows:-

The "Go" should be minimum 9" to 11" maximum.

The "Rise" should be minimum $6\frac{1}{2}$" to $7\frac{1}{4}$" maximum.

The Ratio between "Go" and "Rise" is tested by the formula - "Go" plus twice the "Rise" = 23" to 24".

PREPARATION AND DIMENSIONS.

The lengths of the various parts are shown clearly enough on the plans to take off the lengths of material. The section sizes of material are shown in the drawings and figured in the specification.

The whole of the material is dressed. Generally this is done at the mill. Cut the level steps to a standard length and mould their front edges to the designed shape. The handrails have only a round top edge shape. Tenons are easier to mark and cut on the handrails before moulding them.

The total height between ground and floor levels shown in the drawing must almost agree with the height on the constructed building. Before setting out the material, check the height by means of a stake, straight edge and spirit level, as shown in Fig. 2, and divide the height into the required number of rises, either by dividers on a rod or by mathematical calculation. Check the ratio between the "Go" and "Rise" by the formula.

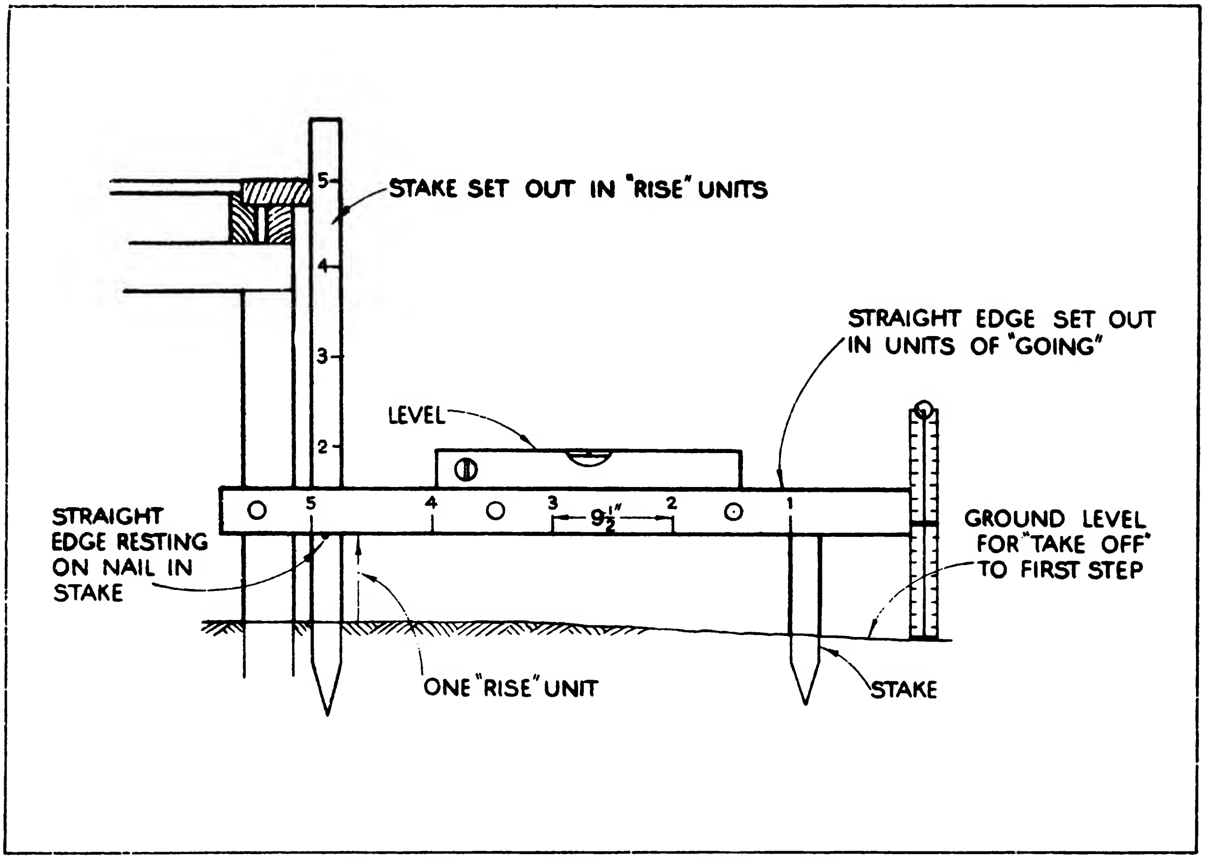


Fig. 2 Method of Checking Total Rise of Steps.

SET OUT THE PITCH BEVEL.

The steel square is used for setting out the step triangle on the strings. If that tool is not available the triangle may be set out with a try square, and the angles transferred from the set out with bevels or a templet. The steel square is preferable.

Make a trial set out on the back of a string to determine the "pitch bevel" and measure where to stop the housings. The trial set out is made by first gauging a pencil line at, say 2", from the edge of the string, placing the square on it to register the Go and Rise, as shown in Fig.3, and marking the pitch bevel on the string by a pencil line. Under that line stand the end of a tread and scribe around it a pencil line section in the position it is designed to occupy. The gauge line may need replacing at a new measurement from the string edge so that it will form the third side of the step triangle and the set out can show a uniform rise and go, regardless of any overlap of treads, moulded edges or variation in width of the material. Set up the steel square with its fence on the edge of the string and figured edges accurately registering the dimensions of the Go and Rise on the new gauge line and note how far the gauge line is from the edge. Clean off the trial set out, or cross hatch its lines thoroughly to avoid the possibility of cutting along wrong lines later on.

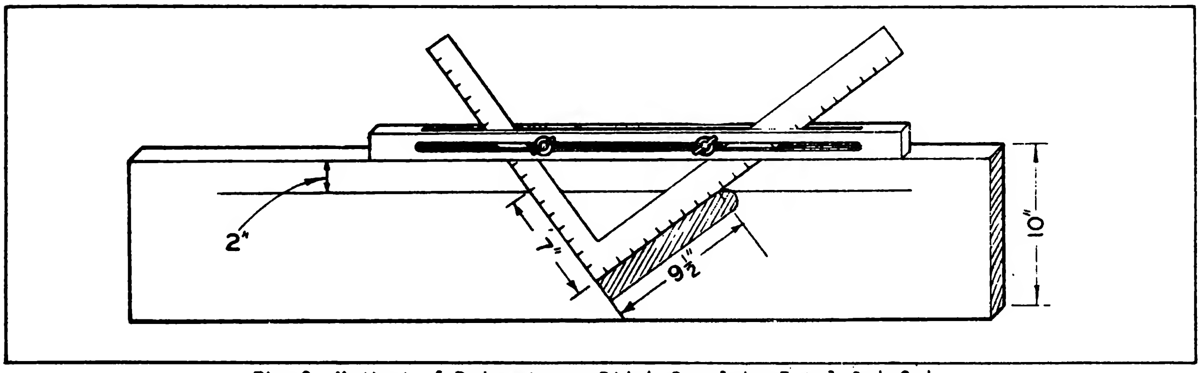


Fig.3 Method of Determining Pitch Bevel by Trial Set Out.

SETTING OUT THE STRINGS.

Secure together by cramps or nails a pair of strings, back to back and with top edges flush. Gauge the pencil line at the distance from the top edges that the trial set out showed as suitable. Use the steel square with its fence remaining at its previous adjustment and set out the faces of the string marking step triangles along the length of the gauged pencil line as shown in Fig.4.

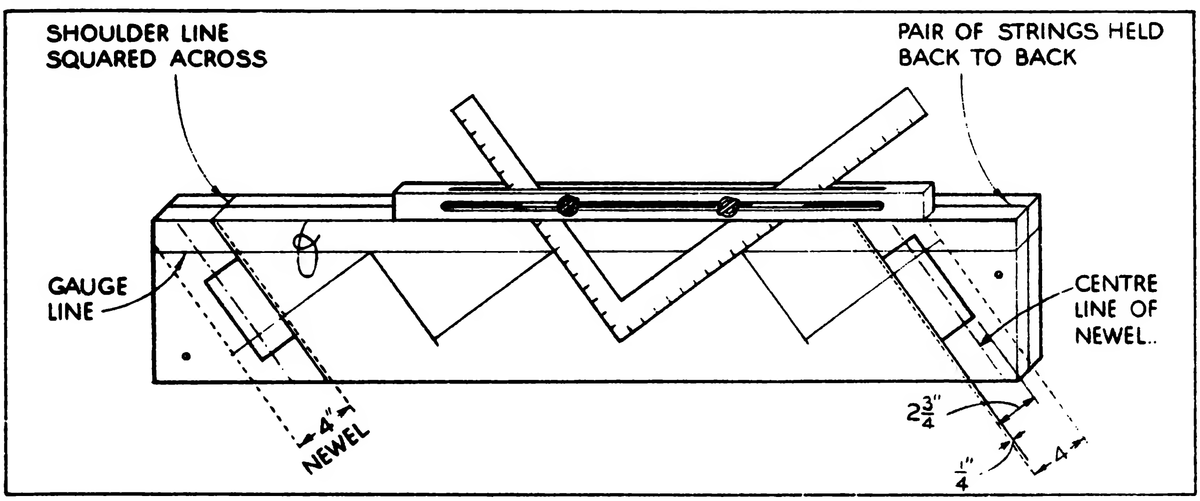


Fig.4 Method of Setting Out the Strings.

The long line is made with a pencil and not scratched with a gauge tool that will deface the string. Mark the shoulder lines to fit against the newels at measured points along the Base Lines of the Step Triangles. These base lines will eventually finish up in levels and therefore present the only set out lines for measuring true sectional sizes of vertical timbers.

Mark on the ends of the strings the plumb cut total length and the haunched tenons for newel joints. Mark on the handrail its length and bevels to correspond with those on the string as shown in Fig. 5. The shape of the housings for the treads are scribed below the base lines of the triangles, either by single steps numbered for place, or from a templet made as a pattern for shape and size.

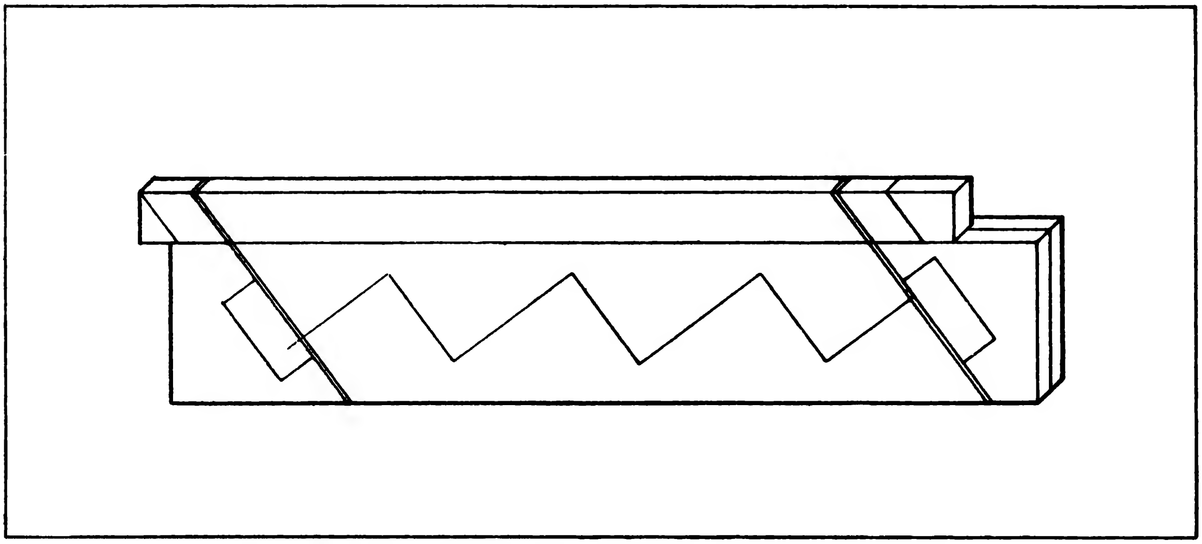


Fig.5 Method of Marking the Length and Bevels on Hand Rails.

SETTING OUT THE NEWELS.

Set out the two short newels for shape of top and the height above the handrail as designed.

On the set out lines of the string a small triangle will be found that should be copied on the newel at handrail height. It is shown hatched over with lines in Fig. 6. The base of the triangle is on top of the bottom tread, the rise is on the shoulder line of the newel and the third side on the gauge line.

Construct a similar triangle on the face of a newel at the handrail line. From the base of that small triangle measure 2'9½" and square line the base of the step triangle.

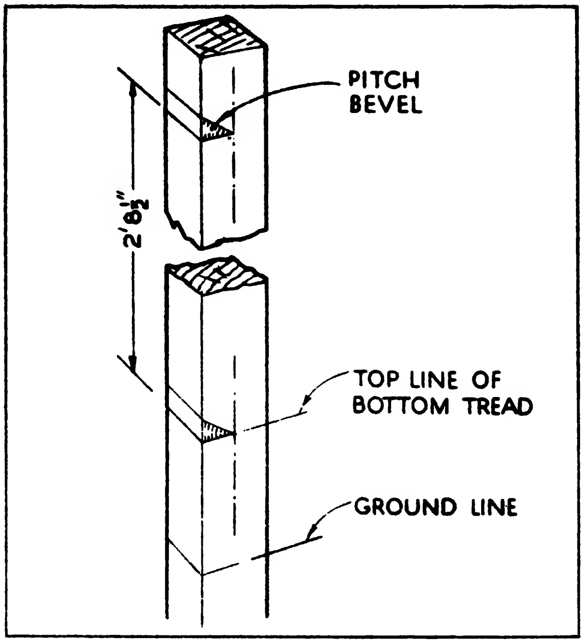


Fig.6 Setting Out the Newels.

It is generally recognised that 2'$8\frac{1}{2}$" is a suitable height for a handrail, measured plumb above the nose of the tread to the top of the handrail. It will be noticed in Fig. 1, page 214, that the landing handrail is higher than the sloping handrail.

Take the base of a step triangle as a starting line, and set out newel mortises and housings to sizes shown on set out string.

Set out the two top newels for shape of top and position of handrail as designed. The length between top of string and top of handrail will be exactly the same as on the short newels. The step housing will differ and its lines are not marked until the string is fitted by its joint to the newel. The lines of the mortise are measured from the set out string.

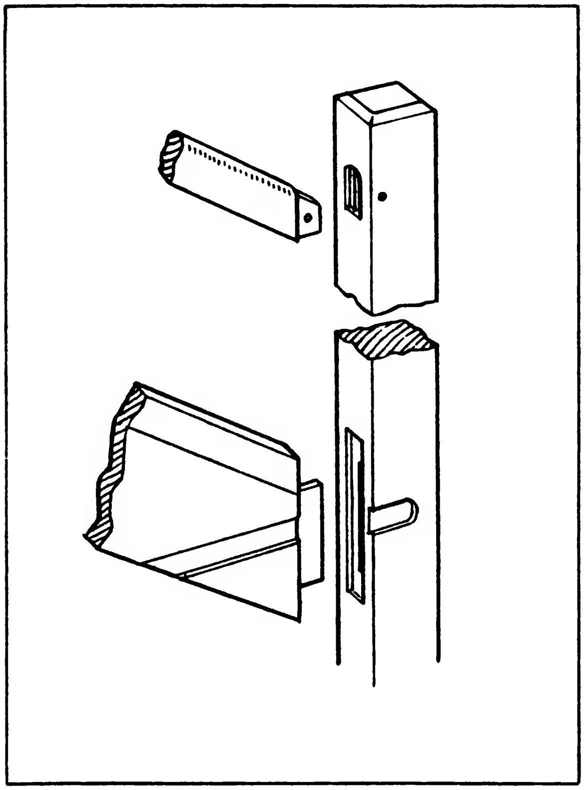


Fig.7 Construction of Newel Joints.

CUTTING AND FITTING THE JOINTS.

Take the pair of strings singly and cut the housings to fit neatly around the front edges and the tops and bottom of the steps.

Cut the tenons on the strings. Cut the tenons on the handrails. Mortise the newels and bore holes for draw pins to pull the shouldered joints tightly against the newels, as shown in Fig. 7.

Mould the top edges of the handrails. On first class stairs all the shoulders are housed in the newels.

ASSEMBLING THE STEPS.

Use paint or creosote when jointing up the side frames. Stand the frames up separately on their sole plates in the excavations. Test their levels before nailing the steps to the strings and ramming the earth securely around the newels.

The final operations are to nail on the braces and clean off any sharp arrisses that may remain on the strings or newels.

CARPENTRY AND JOINERY